Wright & Holch

The Relation Between Weight And Capacity of Prime Movers

Mechanical Engineering

B. S.

1909

THE RELATION BETWEEN WEIGHT AND CAPACITY OF PRIME MOVERS

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THESIS FOR THE DEGREE OF BACHELOR OF SCIENCE

IN MECHANICAL ENGINEERING

IN THE

COLLEGE OF ENGINEERING

OF THE

UNIVERSITY OF ILLINOIS

Presented June, 1909

UNIVERSITY OF ILLINOIS

JUNE 1, 1909

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

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ENTITLED THE RELATION BETWEEN WEIGHT AND CAPACITY OF PRIME MOVERS

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

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OF
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I
INTRODUCTION.

The great amount of material going into the construction of prime movers brings up the question of how or where a saving might be made. If there is some relation between weight and capacity, such relation would furnish some information in answering the question. If the larger prime mover contains much less material per unit of capacity than the smaller, it would be best from the standpoint of economy of material to generate power in as large units as possible and distribute it as needed. If smaller prime movers are of less weight per unit of capacity than large ones, then small power stations would mean a saving of material. The question of economy in the use of the medium used in the engine, or of steam versus gas or water as a medium, or of the transportation of fuel, or other considerations might decide the question against the economy of material used in the construction of the prime mover. But as so many prime movers are used and so many are still to be made the question should be of importance to all interested in the generation of power.

In the following pages are expressed a few thoughts derived from the data and curves given in this paper. The data were gathered in a rather limited time from American manufacturers and from technical journals; and though the curves plotted from these figures do not express the relation between weight and capacity more than approximately, there is good reason to believe that a larger compilation would further substantiate the relation and aid the curves to express it more accurately.

II

METHOD OF OBTAINING DATA.

To obtain the data given in the following pages and plotted in the curves, letters were written to manufacturers giving them the title of the thesis and asking for the ratings and general dimensions of their product. About two thirds of the firms addressed sent data, but only about half of the data received contained weights. Only that material containing weights was used. A small portion of the data were taken form reports given in technical journals.

A list of the makers contributing was made and each name recorded was given a number by which it is designated in the tables of data. This list is not included in the paper because of possible objection by those interested.

III

NECESSARY CALCULATIONS AND ASSUMPTIONS.

The data obtained were not in precisely the shape desired. Some engine builders quoted indicated capacity. This was largely true in the case of steam engines. After due consideration it was decided to use a general mechanical efficiency of ninety percent. The indicated ratings were thus reduced to brake capacities. In the same way shipping weights were given in many cases in the place of the net weights of the machines. There would be a larger percentage of boxing on small than on large units, but a general assumption was made that five percent of the shipping weight of all sizes of machines was boxing. No metal subbases are included in the tables of weights, it being assumed that the subbase is properly a part of the foundation. In all prime movers herein considered the maximum rating is the one considered. No overload capacities are given.

To plot a curve and let each engine represent a point was found unsatisfactory for the weights of engines, even those in the same series of sizes, do not follow closely any given law. If the plotting were done in this way the points would form a cloud rather than follow a line. It was found better to average the weights of engines of a class and within a short range of capacity and use such averages in plotting curves. This was done as can be seen in the data over different ranges of power as seemed desirable.

IV

RIGIDITY OF RELATION BETWEEN WEIGHT AND CAPACITY.

In the tables it is seen that there is a great variation in the total weight and in the weight per horse power of prime movers of the same capacity and class but of different designs built by different makers. This at once tells that there is but little close relation between weight and capacity though theoretically there might be a close one. To make matters worse it was found that for a single design built in a series of sizes by one maker there is the same lack of any law of relation. One engine might have a certain weight, the next size larger may increase but little, and the next a great deal. In many catalogues two consecutive engines in a series would be quoted as having the same weight. In some cases three consecutive engines were treated in this way and in a few cases four. This system is probably due to the use of standard parts which some makers adapt to each two sizes, some to each three, and and some to each four, and partly to the inaccuracy of the production of castings of uniform weight. Some manufacturers advance the weights of the engines of a series by the same amount although the capacity increase is not constant. This is a simple guess on the part of the maker. Some, though few, go so far as to record the actual weights down to the ten pound point of accuracy. To illustrate how far from uniform is the

practice of different makers in making weight per horse power follow some curve two curves, Ia and Ib, have been plotted. These are for two different designs of steam engines by two different makers. The points on curve Ia show how far from accuracy the designs of many engines are made with respect to weight per horse power. No curve was drawn through these points because of their location on the sheet. Curve Ib shows what is more desirable in the design of engines but this relation was uncommon in the data received.

V

REASONS FOR VARIATION IN WEIGHT PER HORSE POWER.

It can easily be seen in the curves of weight per horse power that as a rule there is a more or less sharp bend at the lower end. The rest of the curve is generally straight. The pronounced bend in the case of reciprocating engines is due perhaps to extra weight in small machine parts which for small engines are heavier than would be necessary if designed for strength only. This extra weight on the small engine is a larger percentage of the total than is the case on larger ones where the small parts are designed more for strength and do not carry with them so much unnecessary material. It is easy to see that the weight per horse power would be larger for these small engines than for the ones further up on the curve.

Small engines are built for higher speeds than the larger ones and this necessitates the frame work being heavier to prevent violent vibration. In the larger sizes in which lower speeds are used the bed or frame need not be so heavy in proportion. A similar bend occurs in the curve for marine gas engines, vertical oil engines, and water turbines, but is in the other direction. Why this reversal should be is not clear. Neither is it clear why the bend in the curves for water and steam turbines should be in different directions.

The question of standard parts as was explained before also plays a part among the reasons for variation in the weight per horse power.

VI

CURVES FOR CORLISS ENGINES.

The points on curves IV and V show a relatively strong tendency to follow some law closely. For the standard engine some of the points in the higher powers leave the curve a little, but this is because these points are for individual engines, there not being enough data for these powers to take averages. They also represent the engines of several different manufacturers. Other points along the curves are averages for a number of designs by different makers. The relative closeness with which these points follow the law of some curve is due to the fact that corliss engines are as a rule designed with a

little more accuracy than the average automatic engine.

It would seem at first thought that the heavy duty engine would outweigh the standard duty in weight per horse power, but such is not the case with corliss engines. This fact is true in the case of all makers of these engines from which data could be obtained. The truth is that though the total weight of the heavy duty engine is much greater than that of the standard, the capacity is greater to a higher ratio. The reason is that heavy duty machines are designed to work under such high values of mean effective pressure that they increase in capacity faster than in weight.

VII

LOCOMOTIVES.

The data herein compiled concerning locomotives were were taken from journal publications. As no horse power was given in such data it was necessary to determine the probable capacity of each engine. The power of a locomotive is limited by the capacity of its boiler. In other words the engine is always capable of developing more power than that for which the boiler can furnish steam. To find the maximum rating of the locomotive the capacity of the boiler was therefore determined. Certain assumptions were necessary. From the results of tests of a number of locomotives at St Louis it was found that the average boiler would under favorable conditions evaporate twelve

pounds of water per square foot of heating surface per hour. In the same tests it was found that engines consumed twenty eight pounds of water per horse power hour. Assuming as in the cases of other engines a mechanical efficiency of ninety percent this makes the horse power of a locomotive

$$H.P. = .90 \times 12/28 \times H.$$

where H is the heating surface in square feet. As this is for favorable working conditions and few engines work under such, the capacities as calculated may run a few percent above what other ratings might give.

The above calculations were made for a number of different engines in all the prominent types and then averages for engines ranging over a capacity of a hundred horse power were taken and plotted on curve VI. These points give a relatively good curve. It is interesting to see from the curves and data that the weight per horse power of a locomotive does not differ much from that of the average steam engine although weight is of prime importance in the locomotive.

VIII

GENERAL DISCUSSION OF GAS ENGINES.

The term gas engine in the following discussion includes both gasolene and gas engines unless otherwise specified. The older types of gas engines such as the horizontal and vertical single cylinder engines follow a general law in regard to

weight and capacity. Descending towards the more modern inventions deviations from the law become more or less marked. The marine gas engine varies form the law a little more than the older types, the automobile engine further widens the breach, while among the airship engines the law is absolutely violated. This tendency of the newer inventions to follow no general law is accounted for when it is remembered that the manufacturers have no previous designs to follow but each must rely upon his own ideas in regard to the size and weight of each individual part. That the makers of gas engines do believe that there is a law of relation between weight and capacity is illustrated by the fact that several of the large makers are making alterations in their engines and refuse to give the weights until such alterations are completed.

The weight of an engine depends considerably upon the duty it has to perform. Take for example the case of the marine engine. If it was intended for a racing boat where speed is the only consideration many parts such as the base and levers would be made of aluminum. Also the bearings would be small, the number of revolutions high, the cylinders and other parts as light as possible. Again if the engine were built for heavy duty and long continuous service, the bearing surfaces would be large, the number of revolutions low, and the cylinder walls made thicker so that they could stand up under the called for work.

In case the gas engine is used to drive a generator for electric lighting the weight of the fly wheel is increased

so that the power given the generator will be more constant, and the lights will not flicker with each explosion within the cylinder. This increased weight of the flywheel increases the weight of the engine about ten percent over the ordinary type.

In gas engines the base plate forms part of the engine and here occur many different constructions. The base is designed to obtain symmetry and rigidity, and different manufacturers use different constructions to obtain this end.

IX

LARGE CAPACITY GAS ENGINES.

The horizontal units above a hundred fifty horse power do not follow any general relation in regard to weight and capacity. Contrary to the rule regarding the smaller sizes the weights per horse power increase with the size of the unit. The data upon the large engines were hard to obtain for the large gas engine is a development of recent years, and with most companies is hardly above the experimental stage. This fact and the fact that builders are continually making alterations in their engines explains their unwillingness to give much information on the subject. Much of the data on the large engines were obtained from journal and trade publications. The American engines averaged considerable less in weight per horse power than European makes of the same type engine.

X

HORIZONTAL GAS ENGINES.

The curve plotted for single cylinder engines of one to one hundred fifty horse power capacity followed a general law closer than any other type. The weight per horse power was constant at about two hundred seventy five pounds for engines of twenty-five to one hundred fifty horse power. Below the twenty-five horse power mark the weight per horse power increases rapidly.

XI

VERTICAL GAS ENGINES.

The curve for the vertical gas engines follows the same general law as that for the horizontal engines, the only difference being that the weight per horse power is reduced about twenty five percent. The vertical engine also runs at a higher speed than the horizontal. The general rule that seems to apply to vertical engines is: the more cylinders the less the weight per horse power for the same size unit.

XII

MARINE GASOLENE ENGINES.

The marine engine differs from other gas engines in that the weight per horse power increases with the capacity. The work the engine is expected to perform makes the greatest variation in the weight per horse power. Thus if aluminum is substituted for cast iron in the crank case there would be a decrease in the weight of the engine in the neighborhood of twenty three percent. Some idea of the variation in weight may be gained from the fact that in the large sizes a variation of a thousand percent occured between two well known manufacturers, but on taking an average of all the makers the general relation is fairly well marked out. This shows that each maker has his own general relation between weight and capacity for his own engine.

XIII

AUTOMOBILE GASOLENE ENGINES.

The automobile gasolene engine does not follow any general relation very closely, but the percent of variation among the different makers is small, being less than twenty percent from the average of all. Nearly all the data were obtained from the older companies which perhaps accounts for the absence of any radical construction. Here, as in the marine engine,

the aluminum crank case is sometimes used. One of the ways in which weight is eliminated is with liberal bearing surfaces. Thus, for example, on a four cylinder engine often five bearings are used on a crank shaft. Standard parts play an important part in the relation between weight and capacity on account of the small weight of the engine.

XIV
MOTORCYCLE GASOLENE ENGINES.

From the little data obtained it appears that motorcycle gasolene engines follow the general law well with one exception. This exception was a four cylinder vertical engine the only one of its kind manufactured. This engine weighed considerable less per horse power than the others.

XV
AIRSHIP GASOLENE ENGINES.

The relation between weight and capacity of airship engines is absolutely lacking. The curve was drawn through the greatest number of points possible and it really does not mean much. Such a state of affairs must be expected with such recently designed engines and when it is considered that part of the engines are American manufactured and part made by European makers. The lightness of these engines is acquired by equal-

izing the stresses in the different members. This is accomplished by multiplying the cylinders and arranging them around the shaft, so it is possible to substitute a number of impulses of moderate force for fewer efforts of greater magnitude. Another way to equalize the stresses is to have the cylinders themselves revolve around the shaft and thus do away with the flywheel. This may be done with the cylinders in either a vertical or a horizontal position.

XVI
OIL ENGINES.

Under the head of oil engines may be placed all engines using alcohol, kerosene, or crude oil for fuel. The engines built under the Diesel patent will be called Diesel engines. Oil engines show no general relation between weight and capacity although the vertical type has a few such characteristics. The vertical oil engine weight per horse power is nearly the same as that for the vertical gas engine, while the horizontal type runs about one third greater than the same type gas engine.

The Diesel engine weights vary with the number of cylinders, and are about seventy five percent heavier than the vertical engine. The high weight is caused by the fact that the parts must be heavy to stand the strain caused by the high compression within the cylinder.

XVII
STEAM TURBINES.

Steam turbine data were very hard to obtain on account of the limited number of makers, and because many turbines are direct connected to some other apparatus. This latter cause applies particularly to turbines of the Curtis type which are seldom built without being direct connected to a generator.

The steam turbine is the lightest high-capacity prime mover, and each type follows a general law in regard to weight per horse power very closely. An average for all the types of medium size turbines would show a weight of about thirty pounds per horse power, but would drop a little for the largest sizes. The pressure type has the greatest range of weight per horse power while the Rateau type is the lightest construction. A twelve hundred horse power Rateau unit weighs only six pounds per horse power and the same type has been built even lighter in larger sizes.

The lightness of the steam turbine may be accounted for by the fact that all the rotating parts are perfectly balanced, and with the exception of the bearings no two moving parts are in contact.

XVIII
FLOOR SPACE.

The curves for total floor space against capacity

follow along nearly parallel to the curves for total weight against horse power. The existing existing relation to capacity seems to be a little better worked out than the relation between weight and capacity.

Using a one hundred horse power engine as a base the relative floor space taken up by different prime movers is as follows:

Horizontal gas engines. . . 108 sq. ft. taken as	100. %
Diesel vertical oil engines	81.5
Vertical gas engines.	80.5
Vertical oil engines.	80.
Horizontal Curtis steam turbines.	53.5
Compound automatic steam engines.	53.4
Parson steam turbines	37.
Single stage velocity steam turbines.	11.1
Multiple stage velocity steam turbines.	7.4

XIX

MODERN TENDENCY AS TO WEIGHT PER HORSE POWER.

It can be seen from the curves or tables that turbines, water or steam, are much lighter per horse power than reciprocating engines. This is due mostly to the difference in the speeds used and the necessity for the fly wheel on the steam or gas engine. In late years the advance in the use of high speeds

in machinery has made the building of turbines not only useful but necessary. The invention of the centrifugal pump and centrifugal air compressor has made a field for the turbine. The centrifugal pump of series design has been made to lift water nearly two thousand feet. The fan blower has been made to furnish air compressed to ninety pounds pressure. Either of these machines is of small size and being driven by steam turbines which are also small it is easy to see that a great saving of material can be made by the use of such combinations. There is no question about the superiority of turbines in electric plants; and they are proving of great value as substitutes for steam engines in marine work. In the latter service a saving of space is also of prime importance. There is little doubt that in the future, possibly not far away, there will be a large saving of material by the use of turbines in the place of large blowing engines, reciprocating engines for pumping service, and the like.

XX
CONCLUSION.

The first and most startling thing found from the study of the data and curves in this paper is the fact that the relation between weight and capacity of prime movers is very unstable though there is a general tendency in most types to follow some law. Even in a series of engines of the same

design no law is closely followed. Marine gasolene, vertical oil engines, and water turbines increase in weight per horse power with the capacity of the unit. All other types on which data are given decrease in weight per horse power as the capacity increases. Very large gas engines tend to increase in weight per horse power again after the ordinary sizes are passed. The greatest variation in the relation for all types occurs near the lower end of the curve. The lightest prime mover is the steam turbine. The heaviest is the single acting horizontal gas engine. The latter type also uses more floor space than any other and the horizontal velocity steam turbine uses least.

It might be said that with the increased use of turbines in the last few years the weight per horse power of the total number of prime movers in use is tending to become less. But since the gas engine is the heaviest type and its use is increasing at a rapid rate in the same period of time and its weight is much more above that of the average type than that of the turbine is below the tendency may be ultimately in the other direction. This would depend on the relative use made of these two types.

General Table.

The following table gives in round numbers the range of weight per horse power for the range of horse powers represented in the tables of data.

Type of Prime Mover.	Range of horse power.	Range of weight per H.P.
Steam Engines:		
Simple Automatic	10 to 1000.	100 to 60 lb.
Compound Automatic.	100 to 800.	150 to 75.
Simple Standard Corliss.	125 to 200.	200 to 125.
Heavy and extra heavy duty Corliss.	150 to 1000.	150 to 125.
Locomotives.	750 to 2000.	200 to 150.
Hot Air Engines.	0 to .7	17000 to 5000.
Gas and Gasolene Engines:		
Four Cycle Horizontal.	5 to 150.	110 to 70.
Four Cycle Vertical.	9 to 200.	425 to 200.
Marine.	10 to 100.	60 to 110.
Automobile	20 to 60.	16 to 12.
Motorcycle.	3 to 6	25 to 12.
Airship.	25 to 75.	7 to 2.
Vertical Oil Engines.	0 to 175.	80 to 110.
Steam Turbines:		
Velocity Type.	0 to 300.	80 to 30.
Curtis Type.	0 to 18000.	50 to 25.
Pressure Horizontal.	0 to 10000.	110 to 20.
Water Turbines.	5 to 1500.	5 to 15.

Data

Contributed by

American Manufacturers

and

Collected from

Technical Journals.

Automatic and throttling steam engines

of different designs.

Maker.	Cylinder dimensions.	Delivered horse power.	Weight, total in lb.	Weight per H.P.	Remarks.
9	2 1/2×2 1/2	2.7	215.	80.	
9	3 × 3	4.2	310.	74.	
		3.5	262.	77.	(Average)
5	4×8	8.	710.	89.	
9	4×4	8.	615.	77.	
		8.	662.	83.	(Average)
9	5×5	13.5	550.	41.	
9	4×4	16.	650.	40.	
5	5×10	12.	1090.	91.	2 cylinders.
5	6×10	17.	1560.	92.	
1	6×8	15.	1520.	101.	
1	7×8	20.	1570.	78.	
5	6×12	20.	2440.	122.	
5	7×9	18.	3600.	200.	
3	6×9	12	1450.	121.	
3	7×10.	15.	1750.	117.	
3	8×10	20.	2150.	107.	
2	7×10	20.	1710.	85.	
1	7×10	18.	1520.	84.	
1	6×8	15.	1520.	101.	
1	7×8	20.	1570.	79.	
		16.5	1640.	97.	(Average)

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Remarks.
1	8×10	28.	2660.	95.	
1	9×10	40.	2750.	69.	
1	10×12	50.	4370.	87.	
2	8×10	27.	1710.	63.	
2	9×12	38.	3050.	80.	
2	10×12	48.	3050.	64.	
2	9×14	40.	3200.	80.	
3	10×15	45.	4330.	96.	
3	8×12	25.	2450.	98.	
3	9×12	30.	3150.	105.	
3	10×15	45.	4300.	96.	
4	8×12	30.	4200.	140.	
4	9×12	40.	4900.	122.	
4	10×12	50.	5600.	112.	
5	9 1/2×9	35.	3800.	108.	
5	10×9	40.	4000.	100.	
3	8×10	32.	6000.	188.	
3	9×10	40.	6300.	157.	
5	7×12	25.	2660.	106.	
5	7×14	30.	2950.	98.	
5	9×16	50.	5380.	108.	
8	6×8	22.	3500.	155.	
8	7×8	31.	3550.	113.	
9	5×5	25.	550.	22	(2 Cylinder.)
		36.	3690.	102.	(Average)

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Remarks.
1	11×12	60.	4460.	74.	
1	12×14	75.	6550.	87.	
1	14×16	100.	9900.	99.	
8	9×9	55.	3775.	69.	
8	9×10	61.	4950.	81.	
8	10×10	75.	5200.	69.	
8	11×10	91.	5375.	59.	
2	11×14	75.	6200.	83.	Four valves.
2	12×14	92.	6200.	67.	Four valves.
2	10×16	66.	5700.	86.	Four valves.
2	11×16	80.	6100.	76.	Four valves.
2	12×18	100.	8100.	81.	Four valves.
2	10×12	60.	3800.	63.	
2	12×14	88.	5300.	60.	
2	9×14	50.	3400.	68.	Heavy duty.
7	8×10.	53.	4600.	87.	
7	9×10	67.	4600.	69.	
5	10×16	60.	7400.	123.	
5	11×16	75.	7600.	101.	
5	12×18	90.	13300.	148.	
3	10×12	55.	8700.	158.	
3	11×15	70.	5900.	84.	
3	12×16	90.	7400.	82.	
5	14×20	93.	21000.	226.	
4	10×14	60.	6400.	107.	
4	12×24	80.	12000.	150.	

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Remarks.
4	13×24	100.	14000.	140.	
3	14×18	100.	8700.	87.	
3	13×16	80.	6500.	81.	
3	14×16	90.	7900.	88.	
2	9×14	80.	5700.	71.	2 cylinders.
2	11×14	62.	4300.	70.	
2	12×14	73.	4300.	59.	
2	10×16	55.	4500.	82.	Heavy duty.
2	13×18	98.	7400.	76.	Heavy duty.
1	12×16	55.	4750.	86.	
1	14×18	90.	7400.	81.	
1	11×12.	60.	4460.	74.	
		76.	6800.	90.	(Average)
1	14×16	105.	9900.	94.	
1	15×16	120.	10100.	84.	
1	16×16	140.	10250.	73.	
1	16×20.	120.	10500.	87.	
1	18×22	140.	13800.	99.	
2	14×16	110.	7100.	64.	
2	15×18	130.	11900.	92.	
2	16×18	150.	11900.	79.	
2	14×20.	120.	8700.	72.	Heavy duty.
2	15×20	135.	9100.	67.	Heavy duty.
2	10×16	110.	7800.	71.	2cylinders.

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Remarks.
2	11×16	131.	8500.	65.	2cylinders.
2	13×18	120.	8000.	67.	Heavy duty.
2	14×20	145.	9300.	64.	Heavy duty.
2	15×16	150.	12400.	83.	Four valve.
2	14×20.	145.	10500.	72.	
3	16×18	125.	10900.	87.	
3	16×18	125.	11300.	90.	
3	18×18	150.	12000.	80.	
4	14×21	125.	14000.	112.	
5	15×20.	106.	24000.	226.	
3	14×14	115.	15500.	134.	
3	15×14	130.	16000.	123.	
3	14×18	125.	9700.	78.	
5	15×20	145.	24000.	165.	
7	12×12	132.	7550.	57.	
7	11×12	110.	7500.	68.	
8	13×12	127.	7650.	60.	
8	12×13	119.	7525.	64.	
8	13×13	140.	7675.	55.	
8	12×14	117.	10900.	93.	
8	13×15	149.	10975.	74.	
8	13×14	138.	10950.	94.	
		128.	11050.	86.	(Averages)

Maker.	Cylinder dimensions,	Delivered horse power,	Weight total in lb.	Weight per H.P.	Remarks.
8	14×13	164.	7825.	48.	
8	15×13	181.	7875.	43.	
8	15×14	180.	11750.	65.	
8	15×15	200.	11975.	60.	
8	15×16	193.	14625.	76.	
8	15×12.	172.	7850.	46.	
7	13×12	155.	7750.	50.	
7	13×14	163.	11750.	72.	
7	14×14	190.	11800.	62.	
5	16×24	170.	29500.	174.	
6	13×14	160.	13050.	81.	
6	16×14	200.	13050.	65.	
3	18×22	200.	19200.	96.	
6	15×13	150.	11250.	75.	
5	18×24.	157.	25000.	223.	
5	20×30	200.	45500.	228.	
4	16×21	160.	19500.	122.	
4	18×30	185.	29000.	157.	
3	18×22	180.	16500.	92.	
2	16×16	165.	12400.	75.	Four valves.
2	16×22	200.	14500.	73.	:Four valve :Heavy duty.
2	15×18	160.	13700.	86.	
2	16×18	175.	13700.	78.	
2	16×22	200.	13300.	66.	Heavy duty.
2	13×18	195.	12200.	63.	
1	17×18	160.	15100.	94.	

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H. P.	Remarks.
1	18×18	185.	15400.	83.	
		178.	16400.	91.	(Averages)
2	18×24	215.	16400.	76.	
2	19×24	245.	17800.	73.	
2	14×20	240.	13700.	58.	
2	17×22	230.	14600.	63.	Heavy duty.
2	18×18	235.	17600.	75.	:Four valve
2	17×22	225.	16000.	71.	:Heavy duty.
3	20×24	225.	25500.	100.	
4	20×24	230.	29000.	126.	
5	22×30	242.	57000.	236.	
5	18×24	210.	35000.	167.	
7	15×14	219.	12100.	55.	
7	17×14	230.	12550.	55.	
8	16×16	220.	15775.	72.	
8	17×16	247.	15875.	64.	
		229.	21300.	92.	(Averages)
8	17×17	254.	16650.	66.	
8	18×17	285.	17100.	60.	
8	18×16	177.	16450.	59.	
8	18×18	274.	20000.	54.	
7	16×16	256.	17300.	68.	
7	19×16	296.	18300.	62.	
5	20×30	265.	45600.	172.	
6	18×16	300.	19800.	66.	

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H. P.	Remarks.
5	24×36	295.	70000.	237.	
4	22×27	300.	35000.	116.	
4	23×33	300.	40000.	133.	
3	22×28	300.	29000.	97.	
2	19×18	255.	17600.	69.	Four valve.
2	18×24	255.	18500.	82. :	Four valves
				:	and
2	19×24	285.	20200.	71. :	Heavy duty.
2	18×24.	255.	17100.	67.	Heavy duty.
2	19×24	290.	18600.	64.	Heavy duty.
2	15×20.	275.	14500.	53.	
2	20×27	285.	26800.	94.	
		279.	24400.	89.	(Averages)
2	22×27	345.	28500.	83.	
2	16×22	330.	20500.	62.	
2	20×27	310.	28000.	90.	
2	22×27	315.	29000.	92.	
4	24×36	350.	46000.	131.	
4	24×30	350.	40000.	114.	
3	22×28	350.	35000.	100.	
5	22×30	325.	57000.	175.	
7	18×18	323.	28500.	88.	
8	19×20	315.	25800.	82.	
8	20×20	345.	26125.	76.	
8	19×21	324.	26100.	81.	
8	19×17	320.	17200.	54.	

Maker,	Cylinder dimensions.	Delivered horse power.	Weight total in LB.	Weight per H. P.	Remarks.
8	19×18	305.	20125.	56.	
		329.	30500.	93.	(Averages)
2	17+22	360.	22200.	62.	
2	22×27	375.	29000.	77.	:Four valves
2	22×27	390.	31000.	80.	:Heavy duty.
5	27×36	374.	74000.	198.	
6	21×20	400.	29700.	74.	
7	21×18	395.	29600.	75.	
8	21×18	373.	21200.	57.	
8	21×19.	369.	21500.	58.	
8	21×20	377.	26300.	70.	
8	21×21	397.	26750.	67.	
		381.	31150.	82.	(Averages)
2	18×24	430.	25500.	59.	
7	22×18	435.	30350.	70.	
8	22×21	434.	27150.	63.	
8	22×20	420.	26750.	64.	
8	23×20	418.	27000.	65.	
10	22×22	450.	40000.	89.	
		430.	29500.	69.	(Averages)

Maker.	Cylinder dimensions,	Delivered horse power.	Weight total in lb.	Weight per H. P.	Remarks.
8	23x21	475.	27500.	58.	
2	19x24	480.	27600.	57.	
6	24x20	500.	34200.	68.	
8	24x21	525.	27850.	53.	
2	26x30	490.	38000.	78.	
2	26x30	550.	39000.	71.	:Four valves
2	26x30	550.	41000.	74.	:Heavy duty.
2	22x27	690.	45500.	66.	2 cylinders.
10	25x24	750.	57600.	77.	
2	24x30	830.	57500.	69.	2 cylinders.
2	26x30	975.	61500.	63.	2 cylinders.
		620.	41500.	67.	(Averages)

Compound automatic steam engines

of different designs.

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H. P.	Floor space space in sq.ft.
11	10×16×8	80.	8070.	101.	42.
5	8 1/2×14×16	80.	9500.	119.	90.
10	6 1/2×13×10	60.	8900.	148.	40.
10	8×16×12	100.	13800.	138.	57.
10	8×13×10	60.	9100.	152.	42.
10	9×16×12	100.	14000.	140.	59.
(Average)		80.	10550.	133.	55.
11	12×19×10	120.	11400.	95.	59.
5	9 1/2×16×18	105.	16100.	158.	119.
5	11×20×20	170.	26600.	156.	181.
5	10×18×20	135.	21800.	161.	171.
10	9×18×14	140.	20100.	143.	77.
10	11×18×14	140.	20100.	143.	83.
(Average)		135.	19300.	143.	115.
10	10×20×16	190.	28900.	152.	101.
5	12×22×24	210.	32300.	160.	220.
5	13×24×24	260.	38000.	146.	220.
10	12×23×18	250.	31500.	126.	123.
10	14×23×18	250.	32500.	130.	123.
11	16×25×12	250.	21800.	87.	94.
(Average)		236.	30900.	131.	147.

Maker,	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H. P.	Floor space space in sq.ft.
5	14 1/2x27x30	325.	50400.	155.	350.
10	14x28x20	325.	42300.	130.	136..
10	17x28x20	325.	45700.	141.	137.
11	18x18x14	325.	28500.	88.	122.
(Average)		325.	41720.	128.	186.
5	16x30x30	400.	62700.	157.	350.
11	20x23x15	400.	34200.	85.	202.
(Average)		400.	48450.	121.	276.
10	16x32x22	450.	54000.	120.	161.
10	19x32x22	450.	57000.	126.	176.
(Average)		450.	55500.	123.	168.
11	26x34x16	500.	40800.	82.	165.
5	18x33x36	500.	77000.	154.	495.
(Average)		500.	58900.	118.	330.
5	20x36x36	600.	82600.	138.	514.
11	25x38x17	650.	49300.	76.	204.
10	23x40x24	750.	71600.	95.	222.
10	20x40x24	750.	69800.	93.	229.
11	27x42x18	800.	58800.	73.	264.
11	30x46x20	1000.	75900.	75.	286.
12	42x70x54	25000.	1100000.	44.	1456.

This last engine is the Blooming Mill engine, has 4 cylinders and runs at 200 revolutions per minute.

Standard simple corliss engines.

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Remarks.
13	9×24	40.	12000.	300.	
13	10×24	50.	13000.	260.	
13	10×30	56.	14600.	262.	
13	12×30	81.	18000.	222.	
13	12×36	92.	20000.	218.	
14	12×30	74.	15800.	214.	
14	12×36	70.	16800.	240.	
14	14×36	96.	23000.	240.	
15	10×30	64.	10750.	168.	
15	12×30	92.	13250.	144.	
(Average)		71.	15500.	217.	
15	12×36	104.	15150.	146.	
15	14×36	143.	21000.	147.	
14	14×42	129.	25000.	194.	
14	16×36	145.	30000.	207.	
13	14×30	110.	20000.	182.	
13	14×36	125	23500.	188.	
13	15×30	120.	23000.	192.	
13	15×36	143.	25000.	175.	
13	16×30.	136.	26000.	191.	
(Average)		128.	23200.	180.	

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb,	Weight per H.P.	Remarks.
15	16x36	181.	25000.	138.	
15	16x42	200.	27100.	135.	
13	16x36	153.	18750.	188.	
13	16x42	179.	31000.	173.	
14	16x42	161.	31000.	193.	
14	18x36	179.	33000.	184.	
(Average)		175.	29800.	170.	
14	18x42	204.	24500.	169.	
14	18x48	224.	38000.	170.	
14	20x42	240.	42300.	176.	
15	18x36	213.	30400.	143.	
13	17x42	202.	33000.	163.	
13	18x42.	227.	36000.	159.	
(Average)		218.	35700.	163.	
13	20x42	262..	42000.	160.	
13	20x48	283.	50000.	177.	
14	20x48	266.	46100.	204.	
15	18x42	253.	32500.	128.	
(Average)		266.	44450.	167.	
15	20x42	300.	42100.	140.	
15	20x48	330.	45000.	136.	
15	22x42	362.	48800.	132.	
15	22x48	400.	49300.	122.	
13	22x42	317.	49000.	155.	
13	22x48	339.	56000.	165.	

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Remarks.
13	24×42	378.	63000.	167.	
14	20×60	302.	52100.	173.	
14	22×48	320.	56000.	175.	
14	22×60	365.	60900.	168.	
14	24×48	371.	63900.	172.	
(Average)		344.	53700.	156.	
14	24×60.	432.	70300.	162.	
14	26×48	436.	81600.	187.	
14	26×30	506.	87500.	173.	
15	24×48	462.	60000.	130.	
13	24×48	403.	67000.	166.	
13	26×48	473.	85000.	180.	
(Average)		452.	75230.	166.	
13	28×48	549.	90000.	164.	
14	28×60.	586.	93100.	159.	
15	26×48	542.	68000.	125.	
(Average)		555.	82100.	148.	
15	26×48	612.	80100.	131.	
15	28×54	688.	82000	119.	
14	30×60	643	118000.	183.	
14	32×60	733.	129000.	176.	

Maker,	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H. P.	Remarks.
13	14×30	171.	26000.	152.	
13	15×30	196.	28500.	145.	
(Average)		183.	27250.	148.	
13	14×30	205.	28800.	141.	
13	15×36	235.	30000.	128.	
13	16×30	222.	29000.	131.	
16	12×24	220.	17400.	79.	
14	16×36	203.	33000.	163.	
14	16×42	225.	36000.	160.	
14	18×36	250.	40000.	160.	
(Average)		223.	30600.	137.	
14	18×42	285.	41800.	147.	
13	16×36	267.	34800.	130.	
13	16×42	280.	38900.	139.	
13	17×42	317.	42000.	132.	
13	18×36	339.	41200.	121.	
14	18×48	313.	44600.	143.	
14	20×42.	348.	49400.	142.	
(Average)		307.	41810.	136.	
14	20×48	370.	52200.	141.	
14	20×60	420.	57000.	136.	
14	22×42	410.	55000.	134.	
14	22×48	450.	61100.	135.	
13	18×42	356.	44000.	124.	

Maker.	Cylinder dimensions.	Delivered horse power.	Weight total in lb.	Weight per H. P.	Remarks.
13	20×42	438.	52800.	121.	
13	20×48	417.	55000.	132.	
16	22×48	416.	66200.	159.	
16	18×36	389.	40000.	104.	
(Average)		407.	53700.	132.	
13	22×42	531.	58400.	110.	
13	22×48	505.	64400.	127.	
14	22×60.	505.	64600.	128.	
14	24×45	520.	72500.	139.	
14	24×60.	603.	78800.	131.	
13	24×48	601.	76600.	127.	
(Average)		544.	69410.	127.	
13	24×42	632.	71000.	112.	
13	26×48	706.	87000.	128.	
14	26×26	705.	101000.	143.	
16	32×60	735.	145000.	197.	
14	28×60.	820.	112500.	137.	
13	28×48	819.	106500.	130.	
14	30×60	900.	128100.	142.	
13	30×48	931.	123000.	132.	
14	32×60	1020.	149000.	146.	

Locomotives.

F. . .Freight.		P. . .Passenger.	
Sim. .Simple.		Com. .Compound.	
Con. .Consolidation.		Pra. .Prairie.	
Pac. .Pacific.		Atl. .Atlantic.	
Dec. .Decapod.		Mik. .Mikado.	
Mal. .Mallet.		T.W. .Ten Wheel.	

Maker.	H Surface in sq. ft.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Type.
23	2139.	825	151200.	183.	P Sim American.
25	2143.	830.	166800.	201.	P Sim Atl.
23	2006.	775.	161300.	209.	P Sim American.
26	1466.	558.	126600.	228.	P Sim American.
(Average)		747.	151475.	203.	
21	2497.	960.	167000.	174.	P Sim T.W.
22	2385.	920.	166580.	181.	P Sim T.W.
23	2389.	920.	191300.	208.	P Sim Atl.
21	2470.	953.	200550.	210.	F Com Dec.
23	2493.	960.	192020.	200.	F Com T.W.
24	2413.	930.	191000.	204.	F Sim T.W.
23	2556.	990.	215000.	204.	F Com Con.
(Average)		947.	188930.	197.	
28	2842.	1095.	193500.	177.	F Sim Con.
23	2809.	1085.	208500.	192.	F Sim Con.
21	2587.	1000.	173720.	174.	F Sim T.W.
21	2655.	1025.	209000.	204.	P Com Atl.
23	2676.	1030.	180700.	175.	P Sim Atl.
22	2806.	1080.	162000.	150.	P Sim Atl.
21	2649.	1020.	196000.	192.	P Sim Atl.

Maker.	H Surface in sq.ft.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Type.
22	2700.	1040.	179000.	172.	P Sim T.W.
(Average)		1047.	187500.	179.	
27	2915.	1120.	175000.	156.	P Sim T.W.
22	2917.	1125.	171800.	154.	P Sim T.W.
23	2994.	1150.	203300.	176.	P Sim T.W.
23	3048.	1175.	222000.	189.	P Sim Pac.
27	3016.	1160.	158000.	136.	P Sim Atl.
21	3051.	1175.	196600.	167.	P Com Atl.
23	2862.	1105	200500.	181.	P Com Atl.
21	3000.	1155.	210000.	182.	F Com Dec.
23	2931.	1135.	197000.	173.	F Sim T.W.
21	3094.	1190.	191060.	161.	F com T.W.
22	2874.	1105.	174000.	157.	F Sim Con.
23	2909.	1125.	240000.	213.	P Com Pac.
(Average)		1141.	196000.	171.	
23	3264.	1260.	200500.	159.	F Sim Con.
29	3203.	1235.	203000.	164.	F Sim Con.
21	3245.	1250.	214500.	172.	F Sim Con.
21	3240.	1250.	195000.	156.	P Com Atl.
23	3245.	1250.	200000.	160.	P Sim Atl.
23	3326.	1280.	230500.	180.	P Sim Pac.
23	3327.	1280.	194500.	152.	P Sim T.W.
(Average)		1256.	205428.	163.	

Maker.	H Surface in sq. ft.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Type.
23	3583.	1380.	210000.	152.	P Com Pra.
23	3575.	1380.	216000.	158.	P Sim Pra.
29	3534.	1360.	210800.	155.	P Sim Pra.
23	3414.	1315.	229000.	174.	P Sim Pac.
23	3465.	1340.	200000.	149.	P Com Atl.
23	3556.	1362	275000.	201.	F Sim Dec.
27	3480.	1340.	192000.	143.	F Com Con.
23	3512.	1355.	220200.	162.	F Sim Con.
(Average)		1352.	206625.	153.	F Sim Con.
21	3738.	1440.	210800.	146.	P Com Pra.
21	3878.	1490.	219500.	147.	P Sim Pac.
23	3862.	1490.	200500.	135.	P Com Atl.
23	3705.	1430.	232500.	162.	F Sim Con.
23	3733.	1440.	202600.	141.	F Sim Con.
23	3646.	1410.	209500.	148.	F Com Con.
21	3713.	1430.	227340.	159.	P Com Pac.
(Average)		1446.	215000.	148.	
23	3976.	1530.	234500.	153.	P Sim Pra.
21	4020.	1550.	248200.	160.	P Com Pac.
23	3957.	1525.	230000.	151.	F sIM Con.
23	4046.	1560.	246500.	158.	F Sim Con.
23	4142.	1595.	225000.	141.	F Com Con.
23	4028.	1552.	271000.	174.	F com Mik.
21	4108.	1580.	230800.	146.	P Sim Pac.
(Average)		1556.	240860.	155.	

Maker.	H Surface in sq. ft.	Delivered horse power.	Weight total in lb.	Weight per H. P.	Type.
21	4266.	1643.	214600.	131.	F Com Con.
23	448.	1715.	272500.	159.	P Sim Pac.
23	4682.	1800.	259800.	144.	F Com Dec.
(Average)		1719.	248967.	145.	
21	5390.	2076.	266500.	128.	F Com Dec.
21	5366.	2068.	261720.	126.	F Com Mik.
23	5314.	2050.	410000.	200.	F com Mal.
23	5600.	2160.	334500.	155.	F Com Mal.
23	5585.	2155.	334500.	156.	F Com Mal.
(Average)		2102.	321444.	153.	
21	5703.	2200.	355000.	161.	F Com Mal.

Hot-air reciprocating engines.

Maker.	Cylinder diameter.	Delivered Horse power.	Weight, total in lb.	Weight per H.P.	Remarks.
20	5"	.032	550.	17200.	1 Cyl.
20	6"	.063	800.	12700.	1 "
20	5"	.074	1250.	16900.	2 "
20	8"	.105	1100.	10400.	1 "
20	6"	.211.	2000.	9470.	2 "
20	10"	.211	1800.	8530.	1 "
20	8"	.422	3300.	7820.	2 "
20	10"	.738	3700.	5020.	2 "

Four Cycle Horizontal Gas Engines.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in lb.	Weight per H.P.
32	1.63	400.	1.	500.	500.
45	6.2	300.	2.	900.	450.
46	6.1	390.	2.	940.	470.
32	6.	400.	2.	900.	450.
(Average)	6.1	330.	2.	913.	456.
46		380.	3.	1033.	344.
31	7.2	500.	3.	510.	170.
47		350.	3.	630.	210.
(Average)	7.2	410.	3.	724.	214.
32	7.5	360.	3.5	1200.	342.
32	11.6	240.	3.5	1700.	486.
48	9.	300.	3.5	850.	243.
(Average)	9.3	330.	3.5	1250.	357.
46		350.	4.	1222.	306.
31	9.6	450.	4.5	775.	172.
41	18.	325.	4.5	2256.	501.
(Average)	13.2	350.	4.5	1506.	335.
32	13.3	340.	5.	1900.	380.
45	11.5	700.	5.	1500.	300.
(Average)	12.4	520.	5.	1700.	340.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in lb.	Weight per H.P.
50	15.	300.	5.5	2000.	363.
46		320.	6.	1700.	284.
48	17.5	250.	6.	1800.	300.
31	10.9	425.	6.	1150.	192.
46		310.	7.	2200.	314.
50	22.	275.	7.5	3000.	400.
48	17.5	250.	8.	2400.	300.
31	12.	400.	8.	1360.	170.
31	19.3	300.	8.	2400.	300.
32	19.1	300.	8.	2650.	330.
49		325.	8.	2450.	306.
51	13.3	300.	8.	1420.	177.
46	18.	300.	9.	2700.	300.
49	19.4	300.	9.	3950.	438.
45		240.	9.	3400.	378.
32	20.	300.	9.5	2700.	283.
32	21.	300.	10.	1780.	278.
50.	30.	275.	10.	3500.	350.
36	23.	300.	10.	3200.	320.
52	31.	265.	10.	2826.	282.
51	16.8	300.	10.	2300.	230.
(Average)	19.7	292.	7.5	2470.	330.
46		290.	11.	3100.	280.
50	30.	275.	12	4000.	330.
36	35.5	250.	12.	3750.	310.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in LB.	Weight per H.P.
48	23.5	200.	12.	3700.	310.
31	17.1	380.	12.	2100.	175.
31	30.	250.	12	3900.	283.
32	25.	260.	12.	3300.	275.
49	31.6	275.	12	4230.	350.
45	31.7	225.	12	4000.	330.
51	17.7	300.	12.	2600.	215.
32	35.5	240.	13.	5100.	390.
46.		280.	13.	3675.	280.
32	25.5	260.	14.	3900.	278.
46		270.	15.	3760.	250.
52.	33.8	265.	15.	3300.	220.
45	31.	220.	15.	4600.	306.
32	25.	260.	15.	4300.	285.
49	46.5	250.	15.	4470.	298.
(Average)	28.	264.	12.5	3738.	287.
50	38.	260.	16.	5000.	312.
36	40.	220.	16.	4200.	261.
48	26.	200.	16.	4800.	300.
51.	27.8	260.	16.	4000.	250.
32	42.	240.	17.	6200.	363.
31	38.	225.	18.	5400.	301.
52	47.6	235.	20.	5150.	257.
45	32.6	200.	20	7800.	388.
46.		260.	20.	4230.	212.
50.	38.	260.	20	5500.	276.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in LB.	Weight per H.P.
36	44.	220.	20.	5000.	250.
48	31.5	190.	20.	6000.	301.
51	33.3	240.	20.	4700.	234.
32	35.8	240.	20.	5600.	280.
49.	46.	225.	20.	6750.	337.
(Average)	34.7	232.	17.5	5355.	288.
52.	50.	235.	25.	5650.	225.
46		260.	25.	5450.	217.
45	46.	200.	25.	8000.	320.
50	50.	240.	25.	7000.	280.
36	51.4	180.	25.	6500.	261.
48	33.5	180.	25.	7000.	280.
31	59.	200.	25.	8200.	328.
51	43.	220.	25.	8460.	338.
32	43.	240.	25.	7100.	284.
49.	48.6	200.	25.	7520.	302.
32	52.	240.	25.	8800.	352.
(Average)	47.6	218.	25.	7243.	289.
52	73.	220.	30.	8460.	281.
50.	50.	240.	30.	8000.	265.
31	52.5	320.	30.	10000.	333.
32		230.	30.	6580.	218.
89.	82.5	220.	30.	13400.	446.
51	43.2	220.	30.	9000.	300.
32	46.	240.	30.	10400.	346.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in lb.	Weight per H.P.
49	58.	200.	30.	10300.	343.
(Average)	50.6	236.	30.	9517.	316.
31	63.	200.	35.	9000.	256.
32		200.	35.	8460.	242.
45	48.5	185.	35.	10000.	285.
52	52.5	300.	35.	8930.	255.
32	73.	230.	35.	16000.	458.
(Average)	59.2	227.	35.	10470.	300.
36	62.	180.	40.	9000.	225.
46.		185.	40.	9400.	235.
45	58.5	175.	40.	12000.	300.
32	49.5	240.	40.	12000.	300.
51	53.5	200.	40.	9900.	248.
49	58.	200.	40.	10900.	272.
(Average)	56.3	196.	40.	10530.	263.
31	84.	240.	45.	22000.	490.
31	72.	220.	45.	19500.	434.
(Average)	78.	232.	45.	20750.	463.
31	74.2	180.	50.	14000.	280.
46.		200.	50.	9400.	188.
45	65.	175.	50.	19000.	380.
52	72.	275.	50.	12280.	243.
51	58.5	190.	50.	10700.	214.
32		230.	50.	16000.	320.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in lb.	Weight Per H.P.
49	55.5	190.	50.	17800.	356.
(Average)	64.9	207.	50.	14310.	283.
52	77.5	300.	60.	14700.	244.
46		190.	60.	12700.	212.
32	72.	220.	60.	19500.	326.
51	62.	170.	60.	12200.	203.
32	98.	210.	60.	25000.	416.
49.	61.5	185.	60.	16400.	273.
(Average)	74.	212.	60.	16750.	279.
32	178.	190.	75.	32000.	427.
46		175.	75.	16000.	217.
(Average)	178.	182.	75.	24000.	322.
52		230.	80.	18600.	233.
32	120.	210.	80.	25000.	312.
(Average)	120.	220.	80.	21800.	272.
51		160.	85.	18600.	218.
46		165.	90.	19740.	220.
98		190.	90.	29600.	326.
32	178.	190.	90.	40000.	445.
(Average)	178.	181.	90.	29780.	330.
52	126.	230.	100.	26600.	266.
51	76.5	160.	100.	21600.	216.
32	123.	190.	100.	32000.	320.
(Average)	108.	193.	100.	26700.	267.

Horizontal Gas Engines

Twin Cylinders.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in Lb.	Weight per H. P.
52	183.	200.	200.	42300.	211.
53	310.	150.	250.	75000.	300.
89		180.	300.	79000.	264.
54	456.	120.	300.	114900.	383.
(Average)	383.	150.	300.	96950.	323.
53	778.	130.	600.	231600.	386.
54	1000	130.	600.	186000.	310.
(Average)	889.	130.	600.	208800.	348.
53	816.	80.	1200.	459600.	383.
55	1080.	110.	1200	276000.	230.
56	1080.	110.	1200.	254400.	212.
(Average)	992.	100.	1200.	330000.	275.
53	308	110	1400.	238000.	170.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in lb.	Weight per H.P.
31	160.	150.	125.	40000.	320.
52	159.	200.	125.	34800.	276.
51	84.5	150.	125.	27250.	218.
32	170.	190.	125.	42000.	336.
(Average)	142.	175.	125.	36010.	288.
52	183.	200.	150.	38400.	255.
51	111.	150.	150.	39200.	261.
32	178.	190.	150.	48000.	320.
89.		180.	150.	47600.	318.
(Average)	157.	187.	150.	43300.	288.

Horizontal Gas Engines

above 300 H. P.

54	621.	120.	300.	88500.	295.
53	594.	80.	600.	309000.	515.
55	738.	110.	600.	190800.	318.
56	666.	110.	600.	154000.	258.
(Average)			600.	218200.	364.
12	772.	90.	750.	420000.	560.

Horizontal Gas Engines

Four Twin Coupled Cylinders.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in lb.	Weight per H.P.
54	396.	140.	300.	145200.	484.
54	748.	140.	600.	196000.	327.
54	1212.	130.	1200.	368400.	307.
12	1128.	120.	1200.	295200.	246.
(Average	1170.	125.	1200.	331800.	276.
57	1300.	107.	2000.	835000.	417.
12	3080.	83.5	3350.	1700000.	340.

Vertical Gas Engines

Four Cycle.

30	3.	350.	1/3	420.	1260.
30	3.5	350.	1/2	470.	950.
30	5.2	325.	1.	640.	640.
32	2.1	450.	1.	500.	500.
(Average)			1.	570.	570.
32	6.	400.	2.	900.	450.
32	7.5	360.	3.	1300.	430.
30	9.	300.	3.	1500.	500.
(Average)	8.2	330.	3.	1400.	465.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in lb.	Weight per H.P.
30	11.	280.	5.	2100.	420.
30	13.5	280.	7.	2600.	371.
30	13.5	280.	10.	2900.	290.
30	18.	280.	15.	3800.	253.
33	16.	360.	15.	4000.	266.
(Average)	17.	320.	15.	3900.	259.
30	24.	280.	20.	4100.	204.
30	34.	250.	25.	6700.	270.
33	38.	325.	27.	7700.	286.
30	37.	250.	30.	7300.	244.
33	41.	300.	35.	9200.	264.
(Average)	35.	281.	32.5	7000.	253.
30	39.	270.	40.	9400.	235.
30	42.	270.	50.	10000.	200.
33	46.	275.	55.	13500.	296.
(Average)	44.	272.	52.5	11750.	223.
30	48.	250.	60.	14500.	241.
33	50.	275.	65.	13700.	210.
(Average)	49.	262.	62.5	14100.	225.
30	53.	250.	75.	17000.	227.
33	90.	270.	80.	21200.	265.
(Average)	71.	260.	77.5	19000.	246.

Maker.	Floor space in sq.ft.	R. P. M.	Delivered horse power.	Weight total in lb.	Weight per H.P.
30.	76.	225.	100.	22500.	225.
33	100.	270.	100.	24000.	240.
(Average)	87.	247.	100.	23250.	232.
33	100.	250.	125.	33600.	266.
33	98.		135.	27500.	206.
33	135.		175.	36500.	208.
33	144.		200.	49000.	220.

Marine Gasolene Engines

Four cycle vertical.

Maker.	No. Cyls.	Dimensions Cylinders.	R. P. M.	B. H. P.	Weight total in lb.	Weight per H. P.
38.	1.	5.5×6	400.	5.	340.	68.
39	1.	4.5×5	500.	5.	170.	35.
37	1.		600.	5.	330.	56.
40	1.	5.5×7	600.	6.	600.	100.
37	1.		500.	8.	702.	87.7
36.	2.	4×6	600.	10.	850.	85.
39	2.	4.5×5	600.	10.	265.	26.5
(Average)			530.	7.5	466.	62.
38	2.	6.5×7	400.	12.	1240.	103.3
40	1.	7.5×9	600.	12.	1600.	133.
40	2.	5.5×7	600.	12.	950.	78.
36	2.	5×7	500.	15.	1200.	80.

Maker.	No Cyls.	Dimensions Cylinders.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H. P.
39	2.	5.5×6	500.	15.	420.	28.
37	2.		500.	15.	1265.	84.
(Average)			516.	12.5	1112.	89.
38.	3.	6.5×7	400.	18.	1980.	111.
40.	30.	5.5×7	600.	18.	1450.	80.
36	4.	4×6	600.	20.	1300.	65.
39	4.	4.5×5	600.	20.	430.	22.
(Average)			540.	17.5	1290.	74.
37	3.		500.	22.	1608	73.
40	4.	5.5×7	600.	24.	1800.	75.
36	2.	7×9	375.	25.	2200.	88.
40	2.	7.5×9	600.	25.	3100.	122.
(Average)			520.	22.5	2177.	96.
38	4.	7.5×9	350.	27.	2138.	79.
36	4.	5×7	500.	30.	3000.	100.
39	4.	5.5×6	600.	30.	690.	23.
39	6.	4.5×5	600.	35.	600.	24.
37	4.		500.	35.	1951.	56.
(Average)			510.	30.	1676.	56.
38	3.	8.5×9	350.	36.	2980.	83.
40	3.	7.5×9	600.	37.5	4000.	106.
(Average)			475.	37.	3490.	94.
38	3.	9.5×12	300.	50.	5880.	108.
36	4.	7×9	375.	50.	4500.	90.

Maker.	No. Cyls.	Cylinder dimensions.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H.P.
40	4.	7.5x9		50.	5000.	100.
(Average)			337.	50.	5430.	99.
39	6.	5.5x6	600.	60.	950.	17.
38	3.	11x12	300.	75.	7000.	93.
40	3.	10x14		75.	10000.	133.
(Average)			450.	75.	8500.	113.
38	3.	12.5x14	280.	100.	9257.	94.
40	4.	10x14		100.	12000.	120.
39	6.	6.5x6	1000.	100	1025	10.
(Average)			530.	100.	7445.	75.
41	12.	10x12		300.	7500.	25.

Gasolene Automobile Engines

Four Cycle Vertical.

68	2.	5x4	1500.	18.	302.	17.
69	4.	3.5x4	1500.	20.	270.	16.
70	4.	4x4	1000.	25.	250.	10.
71	4.	4x4.5	1000.	30.	230.	8.
72	4.	4x4.5	1400.	30.	468.	16.
73	4.	4x5	1200.	30.	450.	15.
74	4.	4 4/8x5.5	600.	30.	665.	24.
75	4.	4x5	1200.	30.	320.	11.
(Average)			1000.	30.	420.	15.

Maker.	No. Cyls.	Cylinder dimensions.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H. P.
76	4.	4.75x4.75	900.	35.	560.	16.
77	4.	4x5	1200.	35.	600.	17.
(Average)			1050.	35.	580.	16.5
76	4.	5x5	900.	40.	620.	16.
73	4.	4 7/8x5	1200.	40.	600.	15.
78	4.	4.75x4.75	1500.	40.	565.	14.
75	4.	4.5x5.5	1200.	40.	450.	11.
(Average)			1200.	40.	556.	14.
76	4.	4.75x4.75	1200.	45.	560.	12.
77	4.	4.75x5	1200.	45.	700.	15.
(Average)			1200.	45.	630.	14.
74	4.	4 7/8x5.5	1200.	46.	665.	14.
79	6.	4.5x5	1000.	48.	700.	15.
76	6.	4.5x4.75	900.	50.	710.	14.
75	4.	5x5.5	1200	50.	475.	10.
(Average)			1080.	50.	592.	12.
76	4.	5x5	1200.	52.	620.	12.
75	4.	5x6	1200.	55.	500.	9.
78	6.	4.75x4.75	1500.	60.	735.	12.
76	6.	4.5x4.75	1200.	62.	710.	11.
74	6.	4 7/8x5.5	1200	67.	890.	13.

Four Cycle Gasolene Engines

for

Motorcycles.

Maker.	No Cyls.	Cylinders dimensions.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H. P.
80	1.	2 15/16×3	2200.	3.	75.	25.
80	1.	3 1/8×3 1/8	2200.	3.5	80.	22.8
81	1.	4.25×3.5	2400.	3.5	85.	23.3
(Average)				3.5	82.5	23.5
80	1.	3.25×3 3/8	2200.	3.75	82.	21.8
80	2.	2 15/16×3.5	2200.	6.	100.	16.66
82	4.	2 3/16× 2.25	4000.	7.	60.	8.57

Gasolene Engines

for

Airships.

83	4.	3 5/8×4	1800.	25.	110.	4.8
84	7.			35.	114.	3.25
85	5.	4.5×3.5	1800.	36.	97.	2.7
83	8.	3 5/8×3.25	1800	40.	150.	3.75
86	8.	3.5×4.25	1500.	45.	312.	6.95
83	8.	3.75×4		50.	165.	3.3
85	5.	5.25×5		55.	175.	3.18
87	8.	5 1/16×5 1/16	1000.	55.	250.	4.55
(Average)				55.	212.5	3.85
88	20.		1500.	120.	188.	1.38

Horizontal Oil Engines

Manufacturer 80.

No. Cylinders.	Floor space in sq.ft.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H. P.
1.	7.8	500.	1.5	600.	400.
1.	11.4	400.	2.5	1100.	440.
1.	17.	400.	4.	1700.	400.
1.	19.	360.	6.	1900.	316.
1.	22.	360.	8.	2600.	326.
1.	27.	340.	12.	3900.	325.
1.	38.	275.	18.	5600.	310.
1.	39.	275.	25.	6600.	266.
1.	57.	225.	35.	12000.	343.
2.	62.	275.	36.	11000.	307.
1.	57.	250.	40.	12000.	300.
2.	62.	275.	50.	12500.	250.
2.	87.	225.	70.	23000.	328.
2.	87.	250.	80.	27000.	288.

Vertical Oil Engines

Manufacturer 80.

1.	4.6	600.	2.	400.	200.
1.	4.7	525.	4.	900.	125.
1.	6.8	500.	6.	1200.	200.
2.	6.9	525.	8.	1300.	162.
1.	11.8	425.	12.	2000.	168.
2.	10.4	500.	12.	2000.	168.

No. Cylinders.	Floor space in sq.ft.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H. P.
3.	13.2	500.	18.	3000.	168.
2.	16.7	425.	24.	4000.	168.
3.	20.	425.	36.	6000.	168.
2.	38.	325.	45.	9000.	198.
4.	45.	325.	67.	12000.	178.
4.	53.	325.	90.	19000.	155.
2.	83.	225.	90.	20000.	222.
3.	96.	225.	135.	27000.	200.
4.	110.	225.	180.	34000.	189.

Marine Oil Engines

Manufacturer 80.

1.	1.4	1000.	2.	210.	105.
1.	4.3	700.	3.5	380.	108.
1.	6.3	525	5.	650.	130.
1.	8.	460.	6.	1180.	198.
2.	6.	700.	7.	875.	125.
2.	7.3	525.	10.	1250.	125.
2.	10.	500.	15.	1850.	124.
3.	12.	500.	22.	2400.	108.
4.	13.5	500.	30.	3000.	100.
2.	14.8	450.	30.	3050.	101.
3.	17.	450.	45.	4300.	96.
4.	19.	340.	50.	7000.	140.
2.	27.	450.	60.	5580.	93.

No. cylinders.	Floor space in sq. ft.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H.P.
3.	33.	340.	75.	8500.	112.
4.	47.	340.	100.	10000.	100.
2.	58.	225.	100.	15000.	150.
3.	67.	225.	150.	21000.	140.
4.	77.	225.	200.	27000.	135.

Vertical Oil Engines

Manufacturer 35.

No. Cyls.	Cylinder dimensions.	Floor sq. ft.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H.P.
1.	16 × 24	87.	164.	75.	43000.	570.
3.	12 × 18	88.	220.	120.	33000.	275.
3.	14 × 21	116.	200.	170.	60000.	350.
3.	16 × 24	160.	164.	225.	80000.	355.
6.	16 × 24	330.	164.	450.	155000.	342.

Steam Turbines

One Stage Velocity

Maker.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H. P.	Remarks.
58	20000.	1.5	168.	112.	Non-condensing.
58	20000.	3.	220.	73.	" "
58	16400.	5.	365.	71.	" "
58	16400.	7.	450.	64.	" "
58	16400.	10.	565.	57.	" "
59.	4000.	10.	1200.	120.	" "
61.	4000.	10.	610.	61.	" "
(Average)		10.	791.	79.	
58	16000.	15.	640.	43.	" "
61	4000.	15.	720.	48.	" "
62	3200.	15.	600.	40.	" "
(Average)		15.	653.	43.	
61	3500.	20.	890.	44.	" "
59	4000.	20.	1200.	60.	" "
(Average	3700.	20.	1045.	52.	
61	3500.	30.	1330.	44.	" "
59	3500.	30.	1400.	47.	" "
62	2500.	30.	750.	25.	" "
(Average	3160.	30.	1160.	38.	

Maker.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H. P.	Remarks.
59.	3000.	40.	2200.	55.	Non-condensing.
59	3000.	50.	2400.	48.	" "
62	2500.	50.	900.	18.	" "
61	3000.	50.	2000.	40.	" "
(Average)	2830.	50.	1700.	34.	
59	2500.	60.	2600.	43.	" "
59	2500.	70.	2800.	40.	" "
61	3000.	75.	2760.	37.	" "
59	2500.	80.	2800.	35.	
50		87.	3000.	35.	
(Average)	2620.	72.5	2790.	38.	
59	2400.	90.	4000.	44.	
59	2400.	100.	4500.	45.	
62	1550.	120.	1100.	9.	Two Stages.
61	3000.	120.	3320.	28.	
59.	2400.	125.	4800.	38.	
(Average)	2370.	112.	3520.	33.	
62	1650.	150.	3500.	23.	Two Stages.
59.	2400.	150.	5000.	33.	
57	12000.	150.	10700.	71.	
(Average)		150.	6400.	42.	
59	2400.	175.	5500.	31.	
59	2400.	200.	5500.	27.	
58	12000.	225.	15500.	69.	

Maker.	R.P.M.	B.H.P.	Weight total in lb.	Weight per H. P.	Remarks.
(Average)		200.	8830.	42.	
58	10500.	300.	18200.	61.	
62	1650.	300.	4500.	15.	Two stages.
(Average)		300.	11350.	38.	
58	10000.	350.	18400.	52.	
62	1250.	700.	8000.	11.	Two stages,

Steam Turbines

Multiple Stage Velocity.

Maker.	Floor sq. ft.	R. P. M.	B. H. P.	Weight total in lb.	Weight per H. P.
63	6.	4000.	60.	800.	13.
63	11.	4000.	200.	1600.	8.
63	15.	3600.	300.	3200.	11.
63	33.	3600.	450.	6000.	13.
63	33.	2400.	600.	9000.	15.
64			1200.	7000.	6.

Steam Turbines

Curtis Type

65	58.	2400.	100.	8000.	80.
65	80.	2000.	500.	26000.	52.
65	25.	1800.	940.	38000.	40.

Maker.	Floor sq. ft.	R. P. M.	B. H. P.	Weight total in lb.	Weight per H. P.
65	25.	1000.	2000.	54000.	27.
65	36.	900.	3350.	110000.	33.
65	42.	720.	6700.	215000.	31.
65	48.	720.	12100.	374000.	31.
65	48.	750.	18800.	456000.	24.

Steam Turbines

Horizontal Parsons Type.

66	43.		130.	14000.	107.
66	104.		530.	60000.	113.
66	194.		1340.	102000.	76.
57	262.	1500.	2000.	110000.	55.
			5000.	130000.	26.
67			10000.	180000.	18.

Water Turbines.

Maker.	Wheel diameter.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Remarks.
18	7 5/8	9.8	70.	7.1	
18	7 5/8	12.4	80.	6.4	
18	10	17.	110.	6.5	
18	10	21.6	125.	5.8	
(Average)		15.2	98.2	6.4	
18	13 1/4	29.	180.	6.2	
18	13 1/4	40.	200.	5.	
18	15 1/4	52.	300.	5.8	
18	17 1/2	68.	365.	5.4	
19	12	62.	1000.	16.1	
(Average)		50.	409.	7.7	
17	12	119.	600.	5.	
19	15	96.	1500.	15.6	
19	18	139.	2300.	16.5	
18	20	86.	600.	7.	
18	23	85.	700.	8.2	
18	16 1/2	110.	1200.	10.9	
18	30 1/2	147.	1500.	10.2	
(Average)		111.	1200.	10.8	
18	35	194.	2300.	11.8	
17	15	188.	800.	4.8	
19	21	189.	3193.	16.9	
(Average)		190.	2097.	11.1	

Maker.	Wheel diameter.	Delivered horse power,	Weight total in lb.	Weight per H.P.	Remarks.
19	24	249.	4429.	17.9	
18	40	255.	3000.	11.8	
18	44	307.	3700.	12.1	
17	18	268.	1200.	4.5	
(Average)		269.	3082.	11.6	
17	21	365.	1700.	4.6	
19	27	312.	5120.	16.4	
19	30	385.	6450.	16.7	
18	48	368.	4500.	12.2	
(Average)		357.	4440.	12.4	
18	52	479.	5500.	11.5	
17	24	479.	2700.	5.6	
19	33	466.	7700.	16.6	
(Average)		475.	5300.	11.2	
19	36	555.	8775.	15.8	
19	39	651.	11490.	17.7	
18	56	629.	6200.	9.8	
17	27	604.	3000.	4.9	
(Average)		609.	7266.	12.3	
17	30	746.	3800.	5.1	
19	42	755.	13300.	17.6	
18	61	737.	8200.	11.1	
(Average)		746.	8430.	11.2	

Maker.	Wheel diameter.	Delivered horse power.	Weight total in lb.	Weight per H.P.	Remarks.
19	45	867.	15600.	18.	
17	33	824.	5500.	6.67	
(Average)		845.	10500.	12.3	
18	66	933.	10500.	11.2	
17	36	981.	6200.	6.2	
19	48	987.	16722.	17.	
(Average)		967.	11140.	11.5	
19	51	1110.	22560.	20.3	
17	39	1150.	7800.	6.8	
(Average)		1300.	15180.	13.5	
19	54	1200.	26500.	21.2	
17	42	1292.	9300.	7.2	
(Average)		1270.	17900.	14.2	
19	57	1390.	34379.	24.7	
17	60	1389.	21000.	15.1	
(Average)		1389.	27689.	19.9	
17	45	1434.	10900.	7.6	
19	60	1540.	42000.	27.3	
17	48	1564.	14300.	9.15	
17	63	1532.	24000.	15.7	
17	72	1522.	30000.	19.7	
(Average)		1539.	27575.	17.9	

Curves

Horse Power against

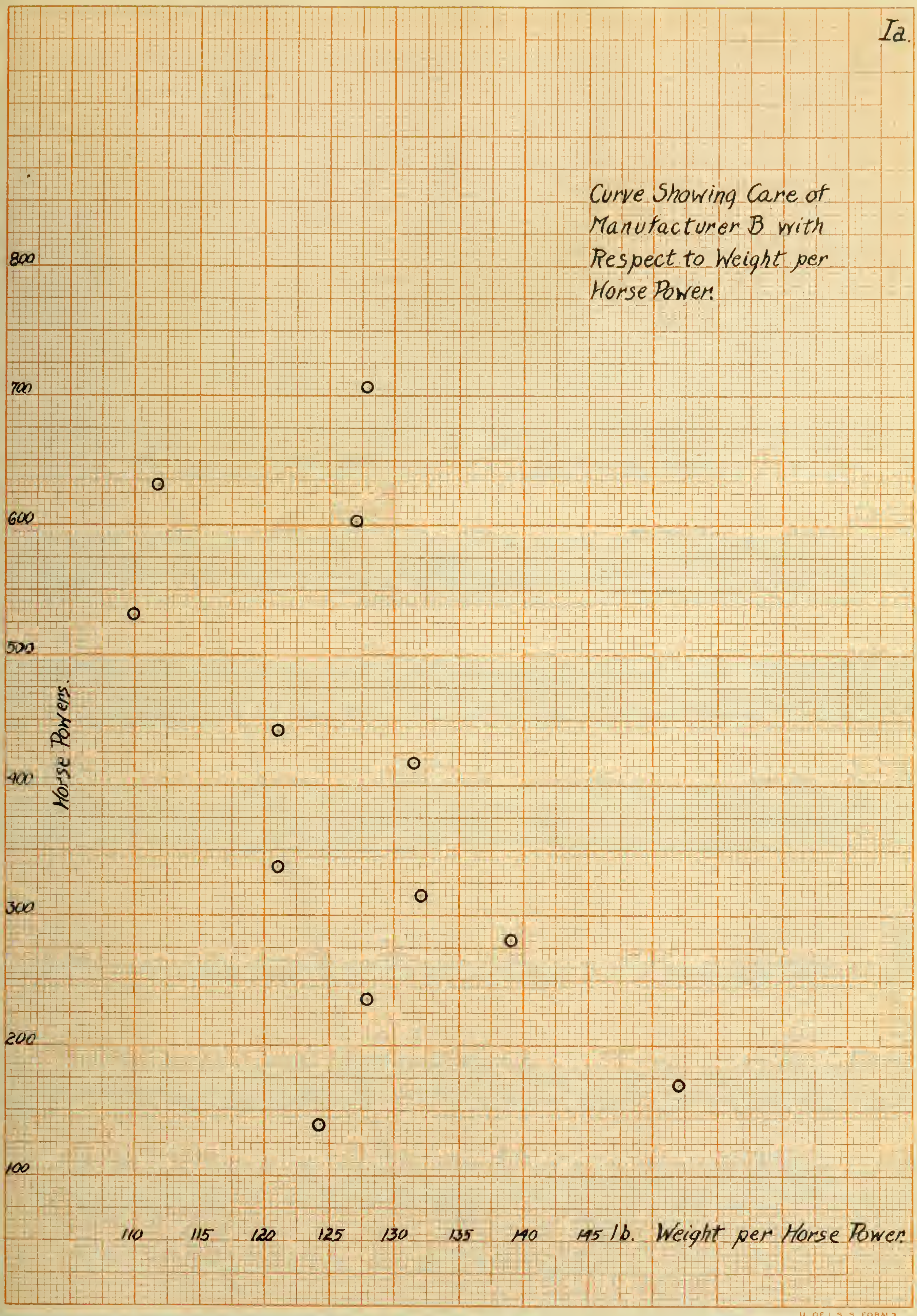
Total Weight, Weight per Horse Power,

and Floor Space

Plotted from

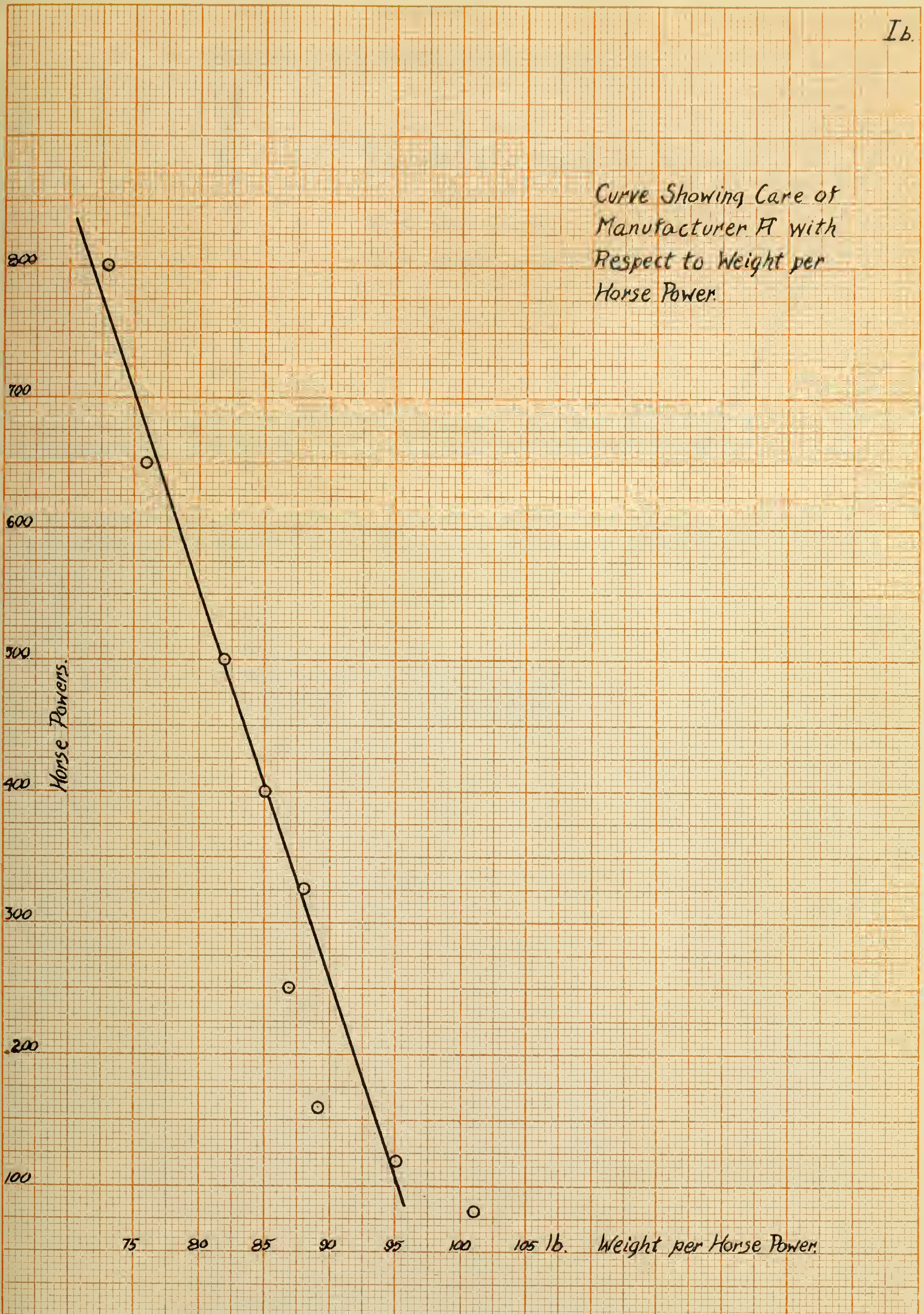
the

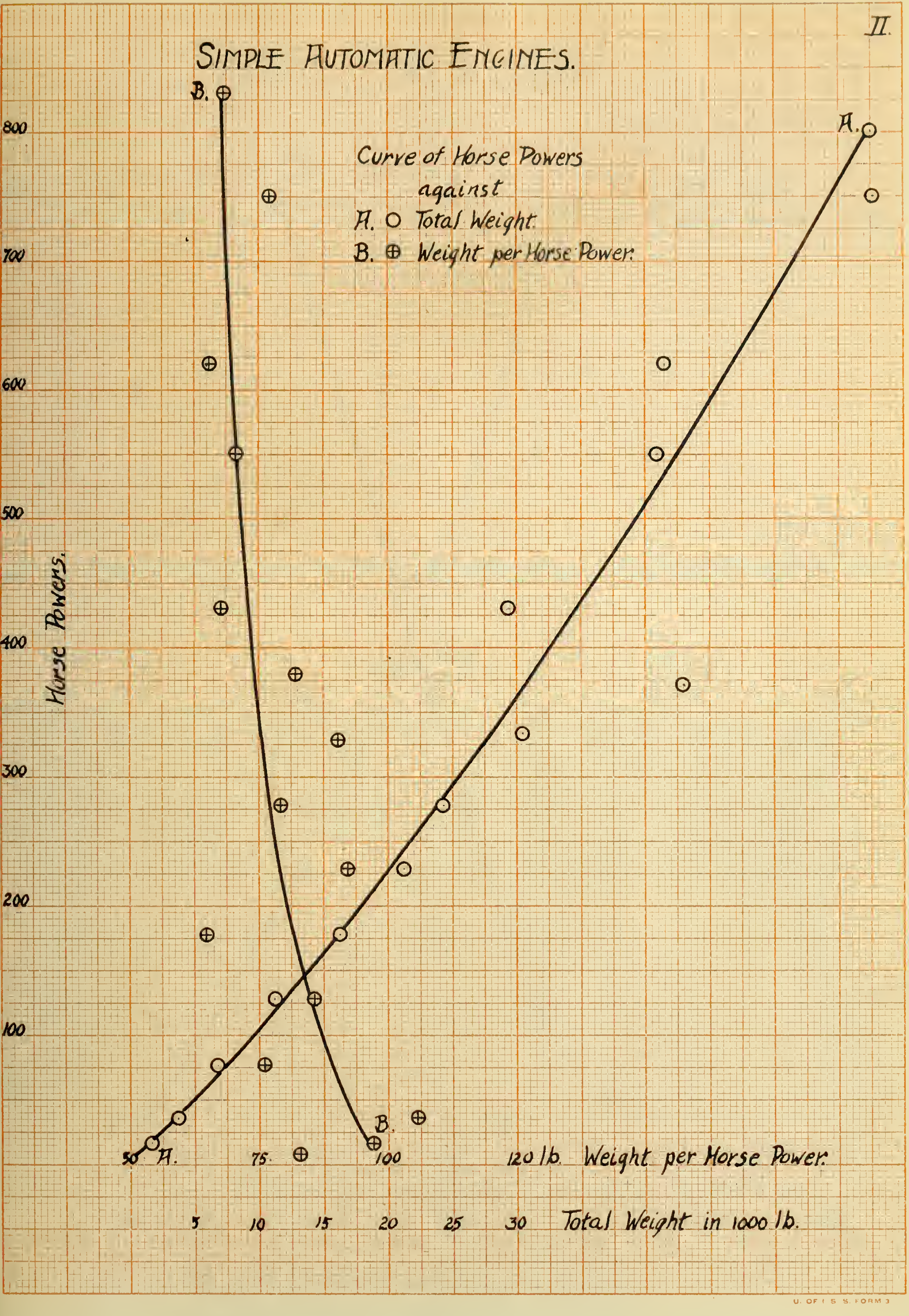
foregoing Data.

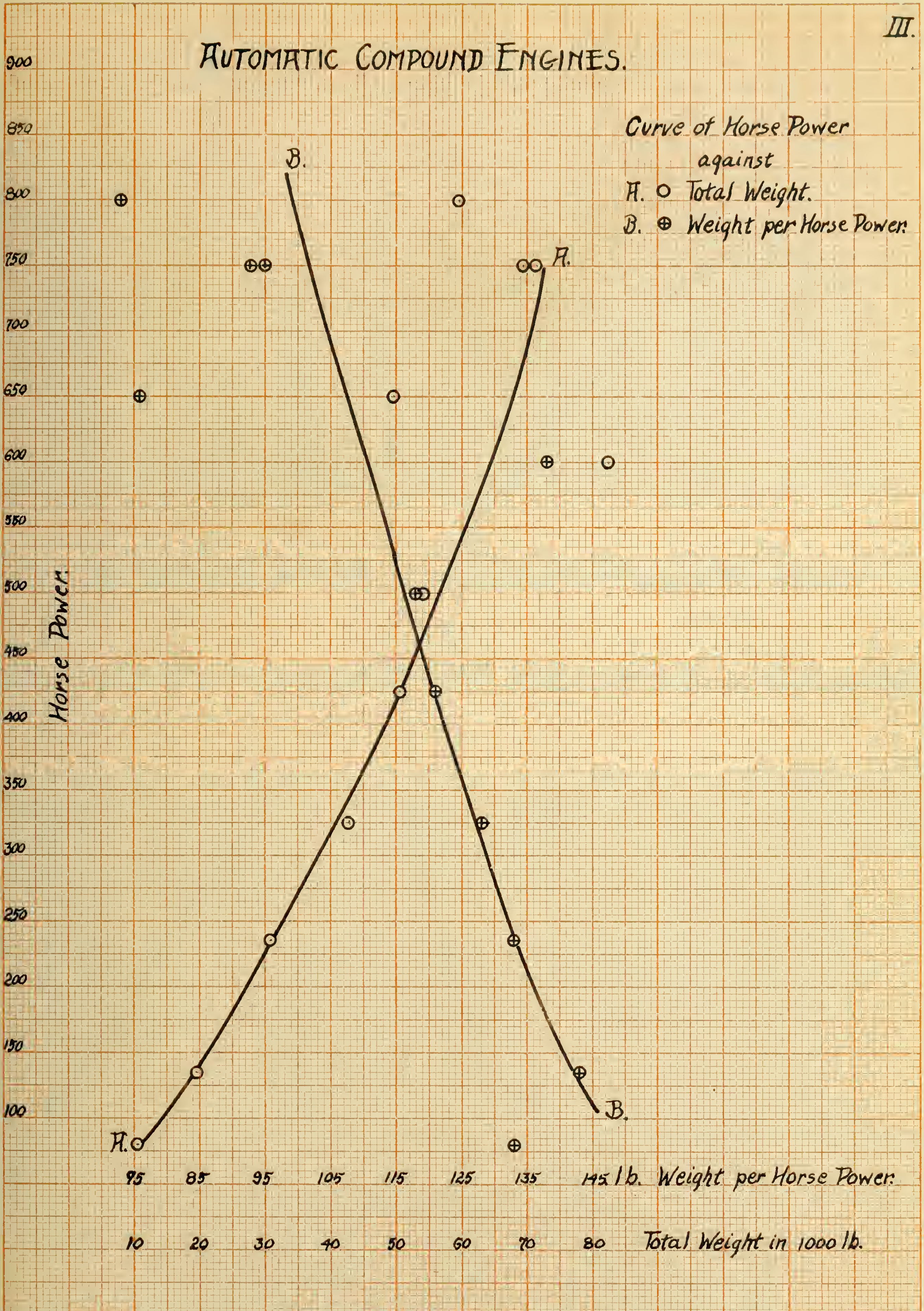


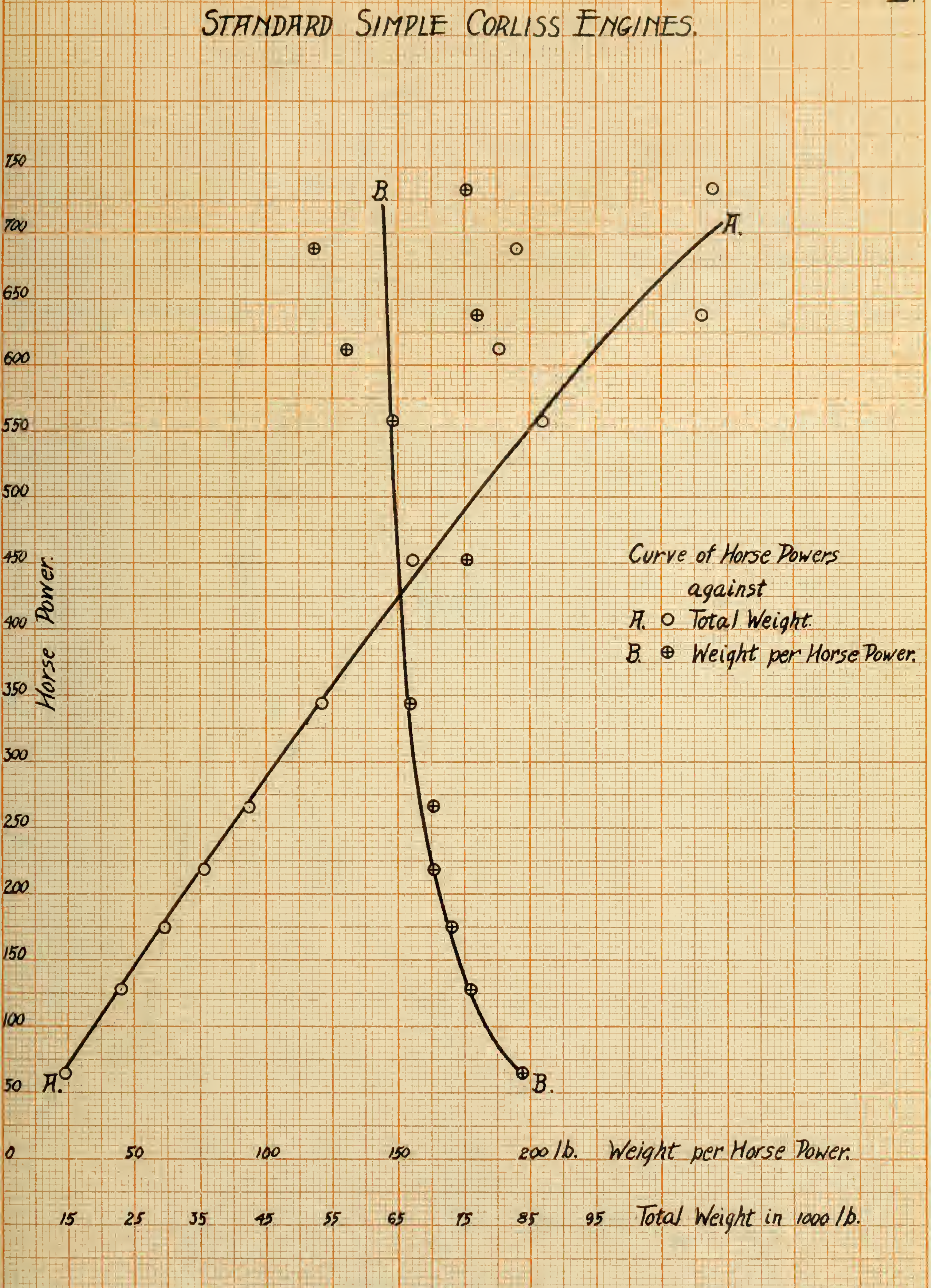
Ia.
Curve Showing Care of Manufacturer B with Respect to Weight per Horse Power.
800
700
600
500
400
300
200
100
Horse Powers.
110
115
120
125
130
135
140
145 lb. Weight per Horse Power.
U. OF I. S. S. FORM 3

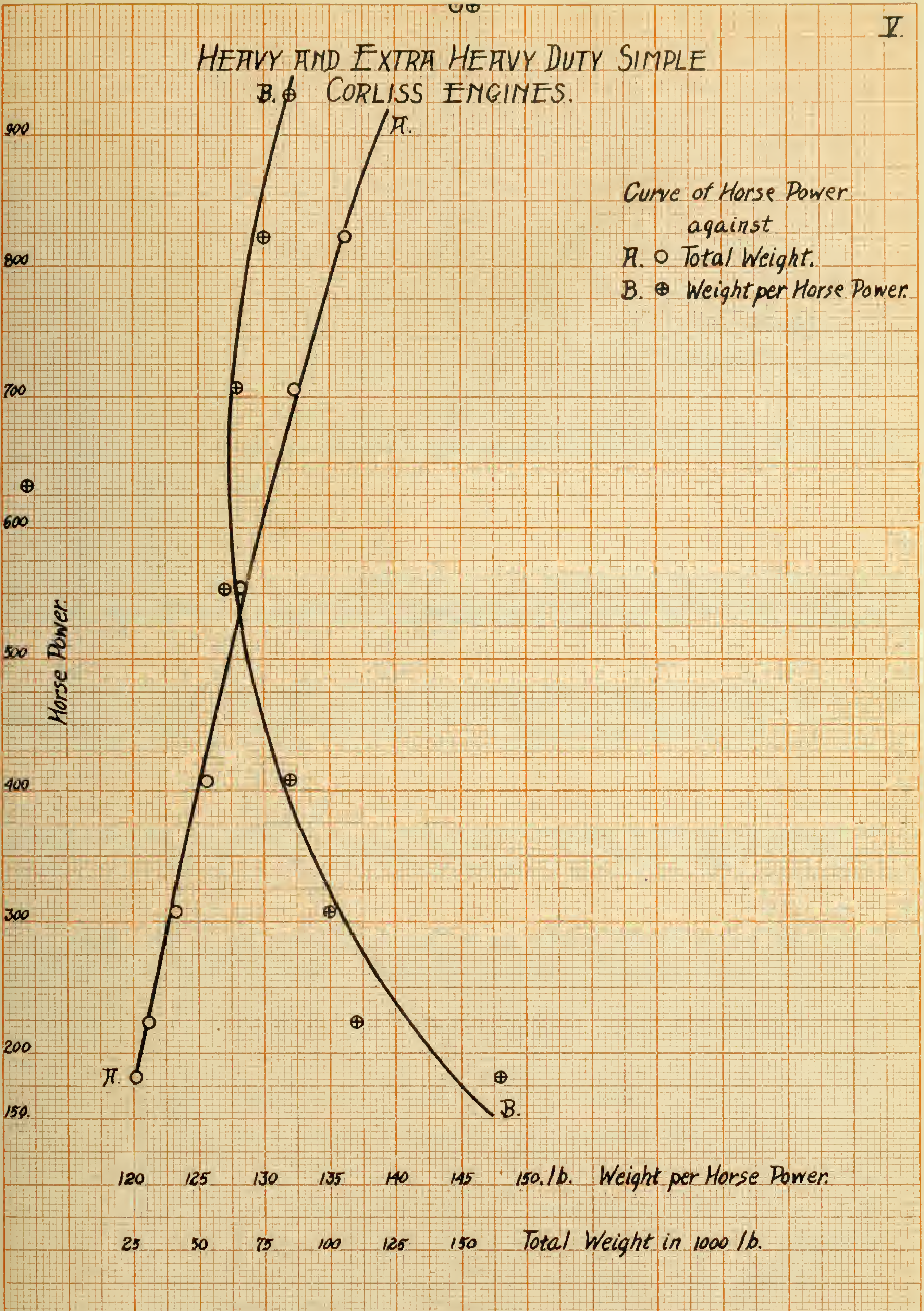
Ib.

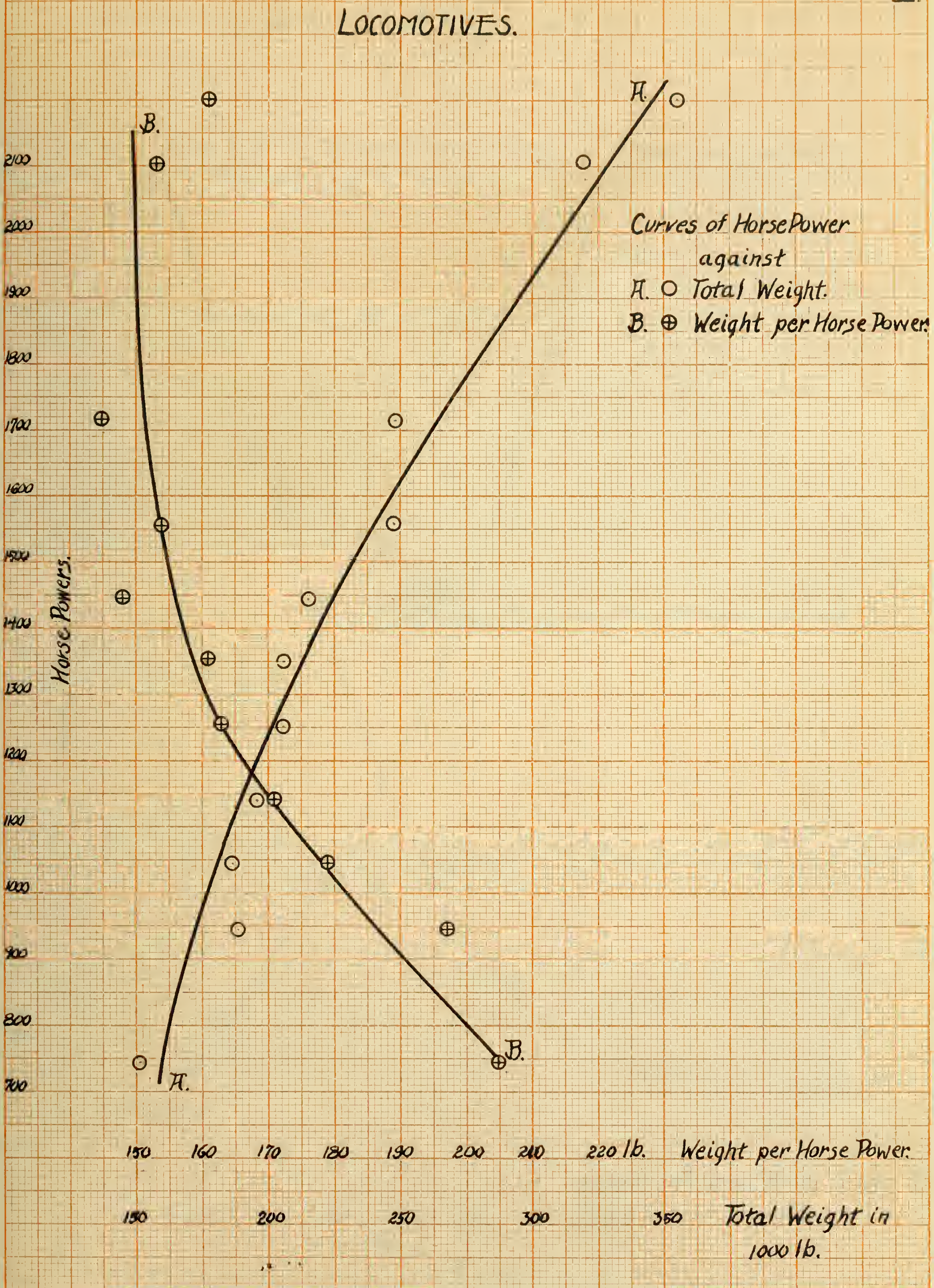

Curve Showing Care of Manufacturer A with Respect to Weight per Horse Power.
Horse Powers.
800
700
600
500
400
300
200
100
75
80
85
90
95
100
105 lb.
Weight per Horse Power.

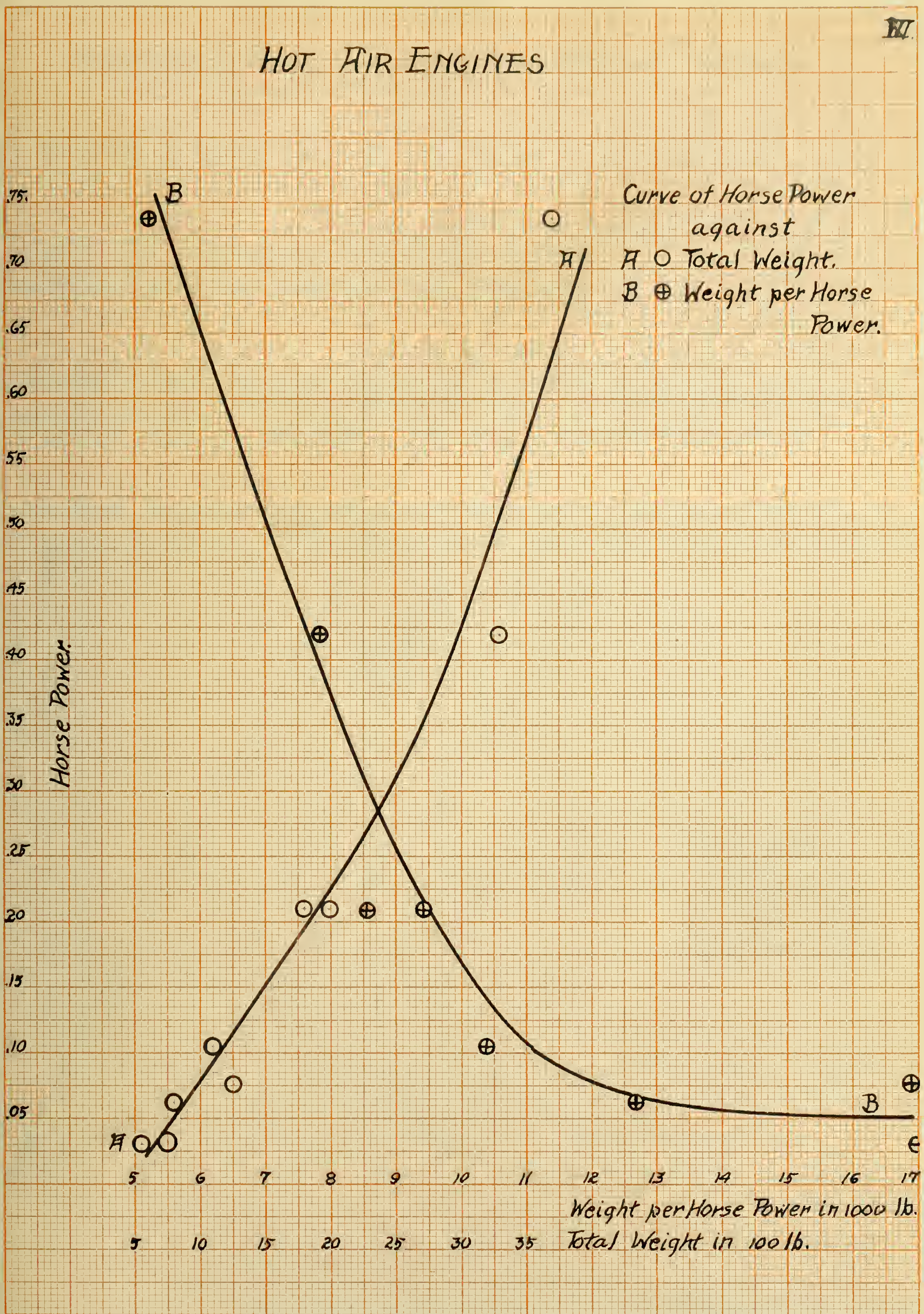

SIMPLE AUTOMATIC ENGINES.
Curve of Horse Powers
against
A. ○ Total Weight.
B. ⊕ Weight per Horse Power.
A.
B.
Horse Powers.
800
700
600
500
400
300
200
100
50
75
100
120 lb. Weight per Horse Power.
5
10
15
20
25
30
Total Weight in 1000 lb.

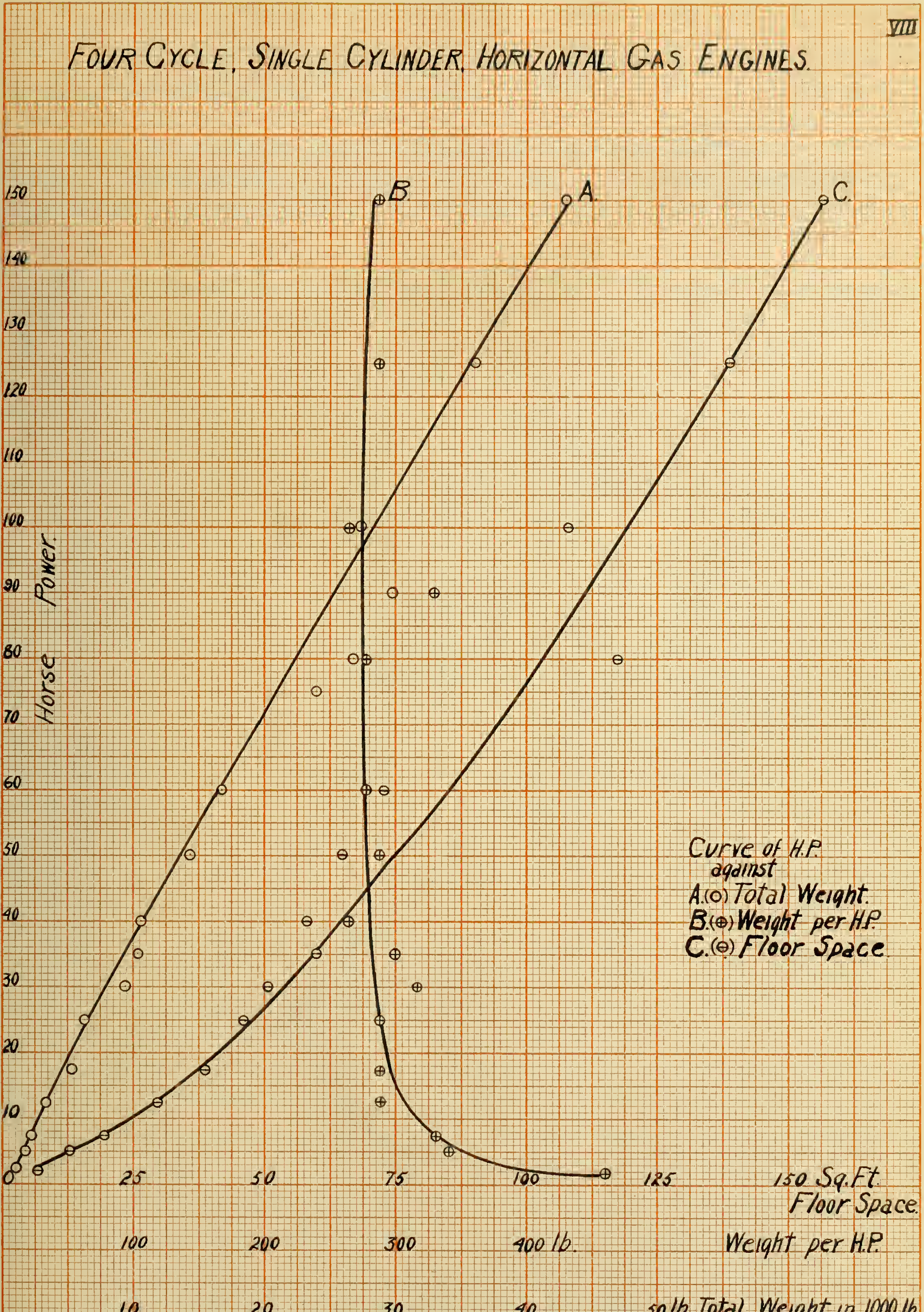

Automatic Compound Engines.
Curve of Horse Power against
A. ○ Total Weight.
B. ⊕ Weight per Horse Power.
Horse Power
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
A.
B.
75 85 95 105 115 125 135 145 lb. Weight per Horse Power.
10 20 30 40 50 60 70 80 Total Weight in 1000 lb.

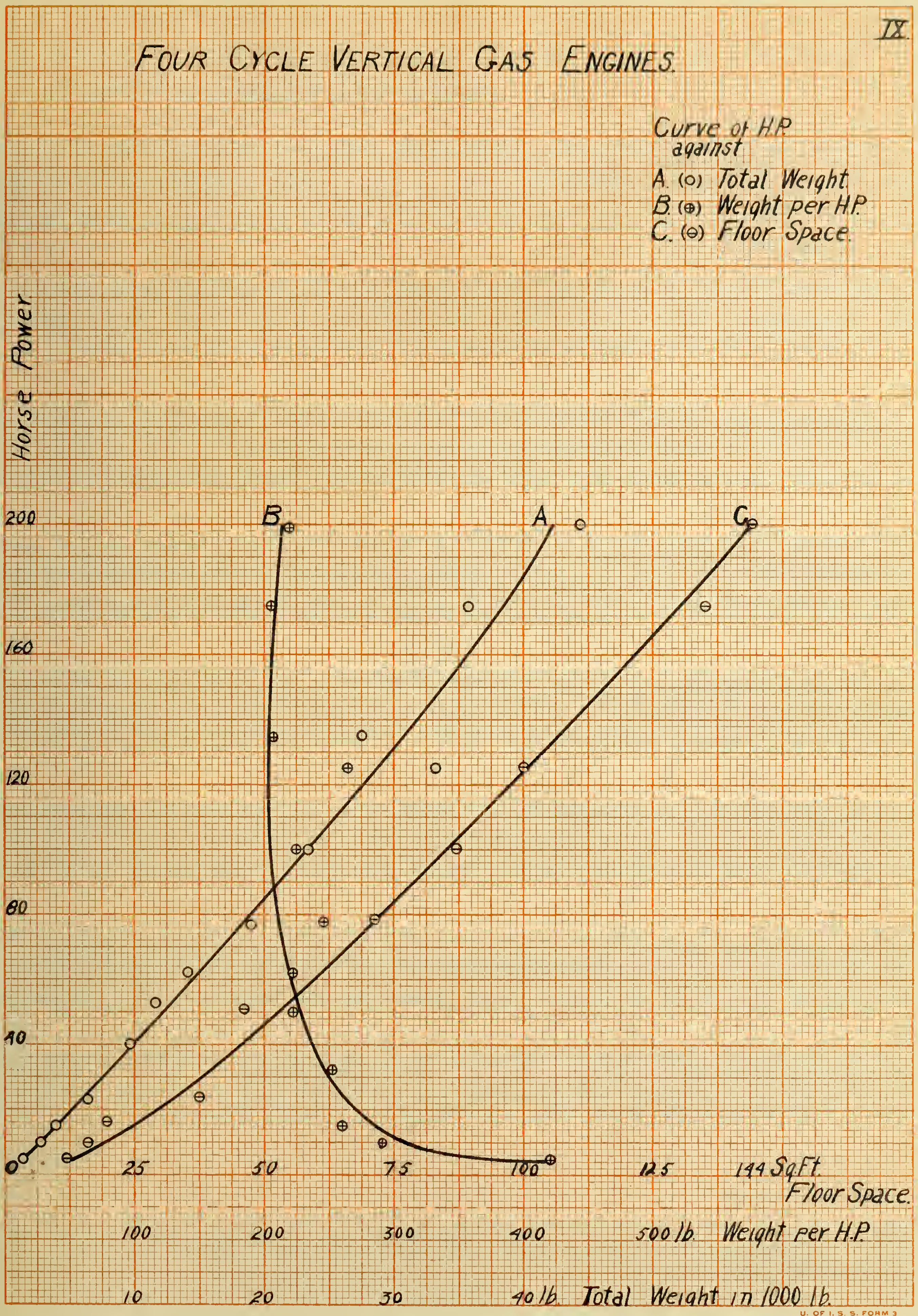

STANDARD SIMPLE CORLISS ENGINES.
Horse Power.
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
50
100
150
200 lb. Weight per Horse Power.
15
25
35
45
55
65
75
85
95
Total Weight in 1000 lb.
A.
B.
Curve of Horse Powers
against
A. ○ Total Weight.
B. ⊕ Weight per Horse Power.


HEAVY AND EXTRA HEAVY DUTY SIMPLE
CORLISS ENGINES.
B.
A.
Curve of Horse Power
against
A. ○ Total Weight.
B. ⊕ Weight per Horse Power.
900
800
700
600
500
400
300
200
150
Horse Power.
120
125
130
135
140
145
150. lb. Weight per Horse Power.
25
50
75
100
125
150
Total Weight in 1000 lb.

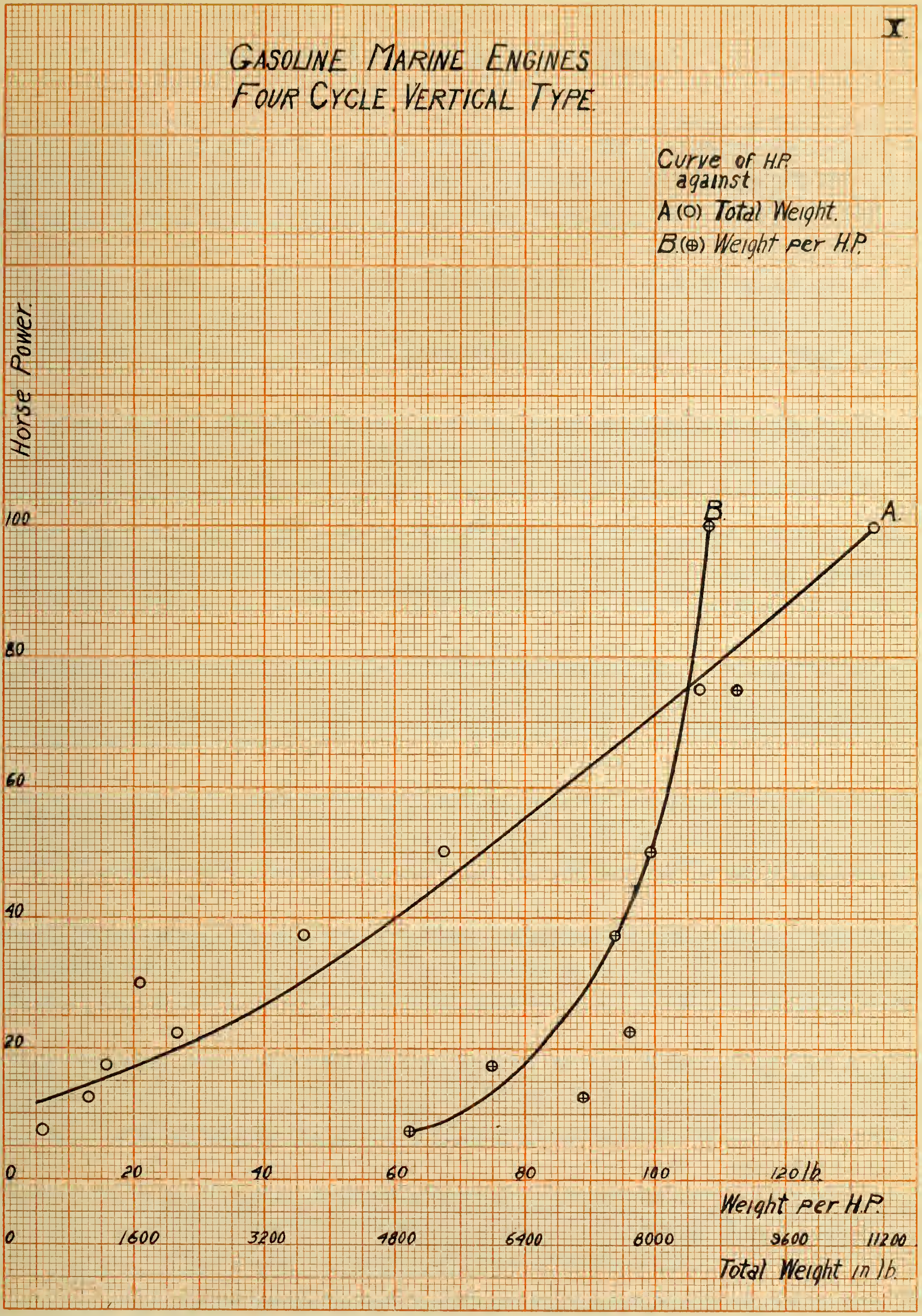

LOCOMOTIVES.
Curves of Horse Power
against
A. ○ Total Weight.
B. ⊕ Weight per Horse Power.
Horse Powers.
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
A.
B.
150 160 170 180 190 200 210 220 lb. Weight per Horse Power.
150 200 250 300 350 Total Weight in 1000 lb.

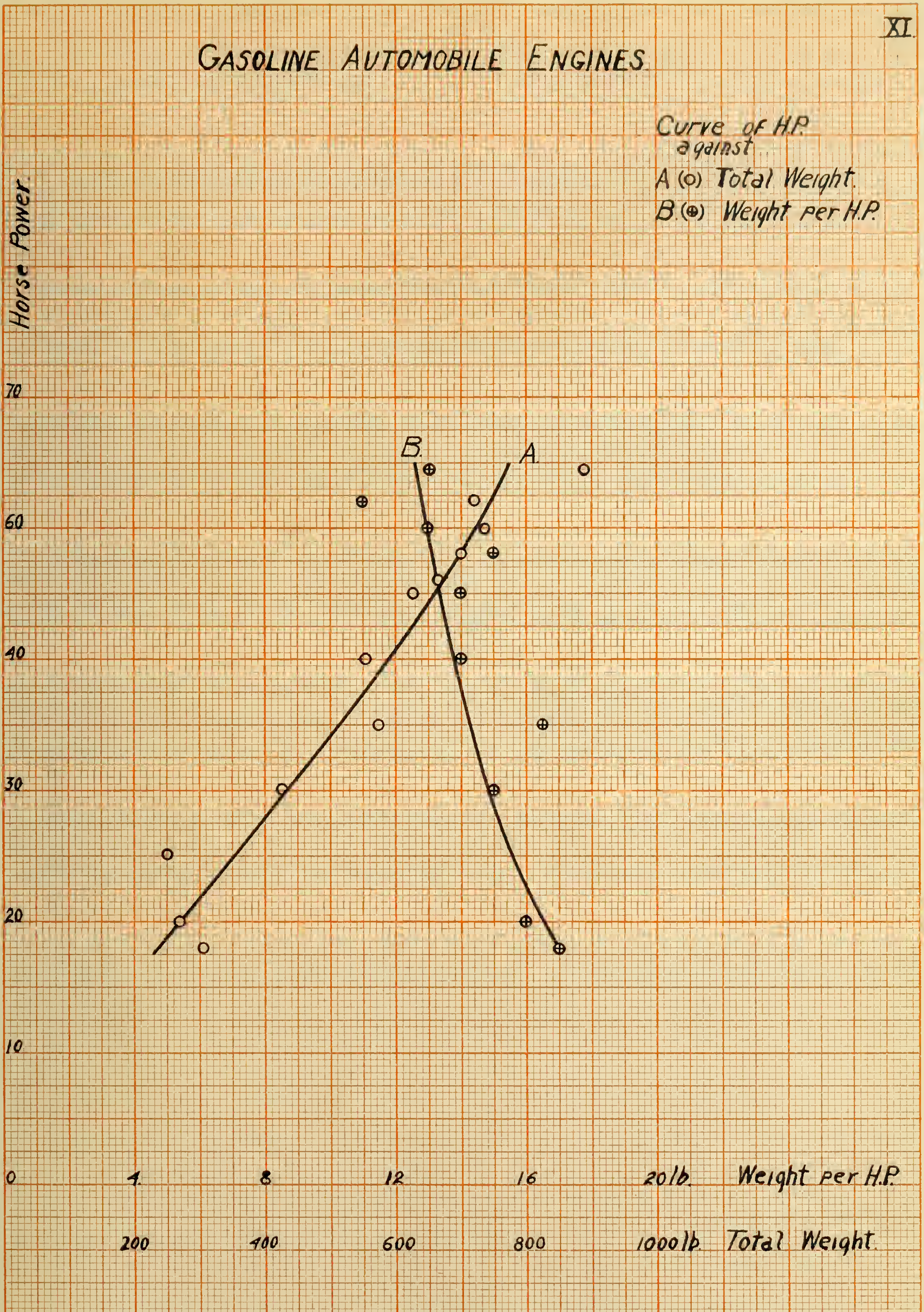

IV.
HOT AIR ENGINES
Curve of Horse Power
against
A ○ Total Weight.
B ⊕ Weight per Horse Power.
Horse Power.
.75
.70
.65
.60
.55
.50
.45
.40
.35
.30
.25
.20
.15
.10
.05
A
B
5 6 7 8 9 10 11 12 13 14 15 16 17
Weight per Horse Power in 1000 lb.
5 10 15 20 25 30 35
Total Weight in 100 lb.
U. OF I. S. S. FORM 3

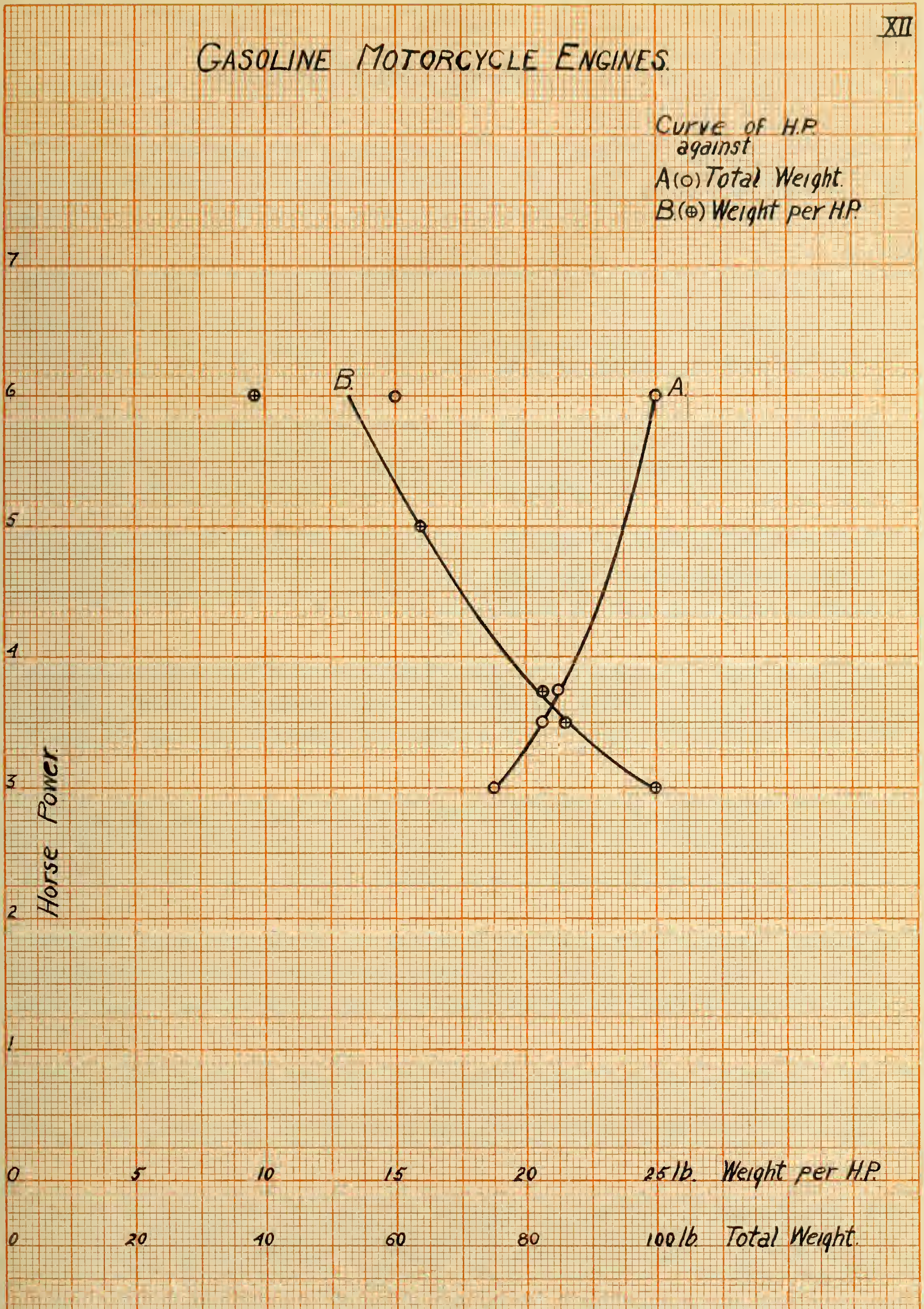

FOUR CYCLE, SINGLE CYLINDER, HORIZONTAL GAS ENGINES.
Horse Power.
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
B.
A.
C.
Curve of H.P. against
A.(⊙) Total Weight.
B.(⊕) Weight per H.P.
C.(⊖) Floor Space.
25
50
75
100
125
150 Sq. Ft.
Floor Space.
100
200
300
400 lb.
Weight per H.P.
10
20
30
40
50 lb. Total Weight in 1000 lb.



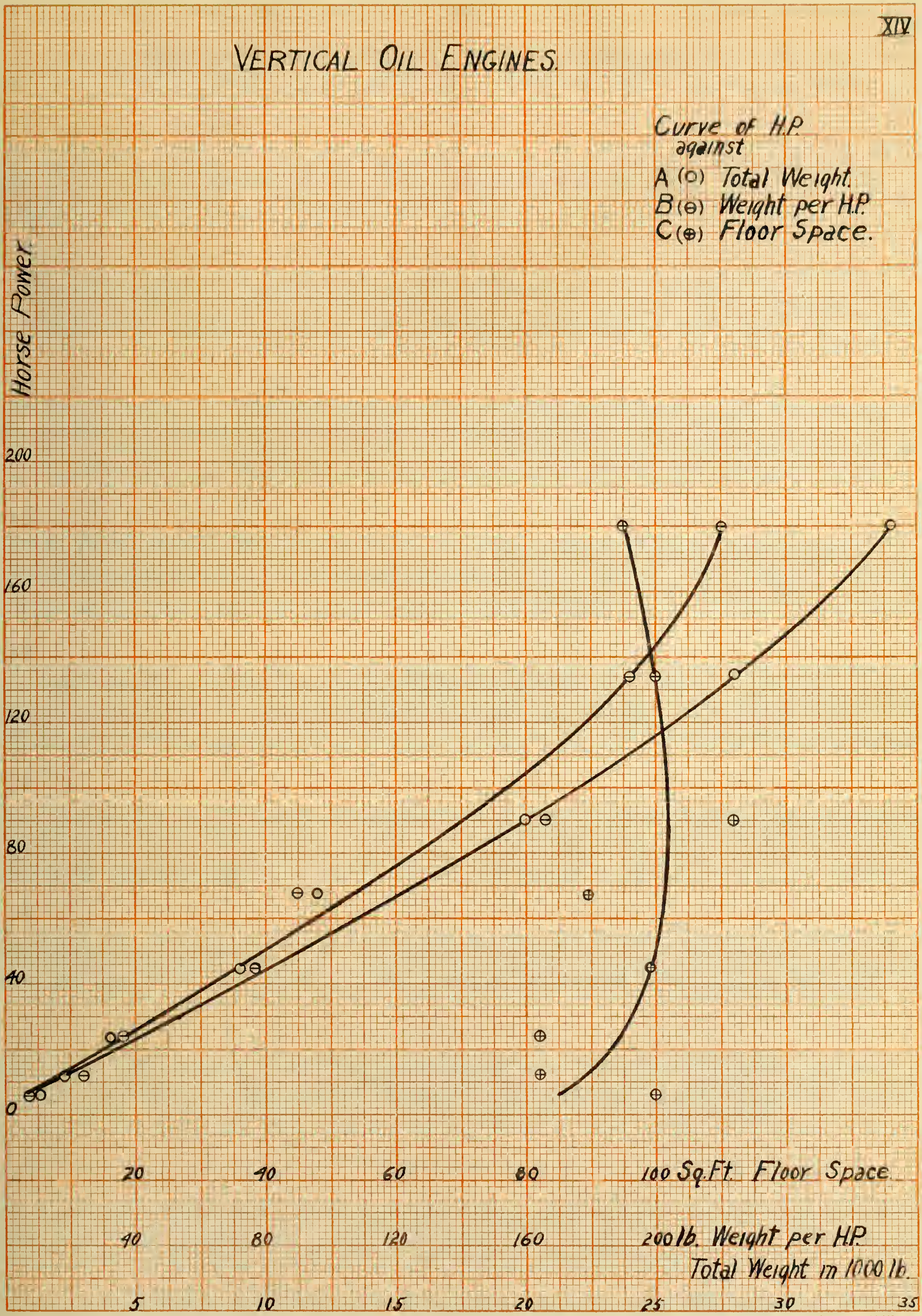
U. OF I. S. S. FORM 3

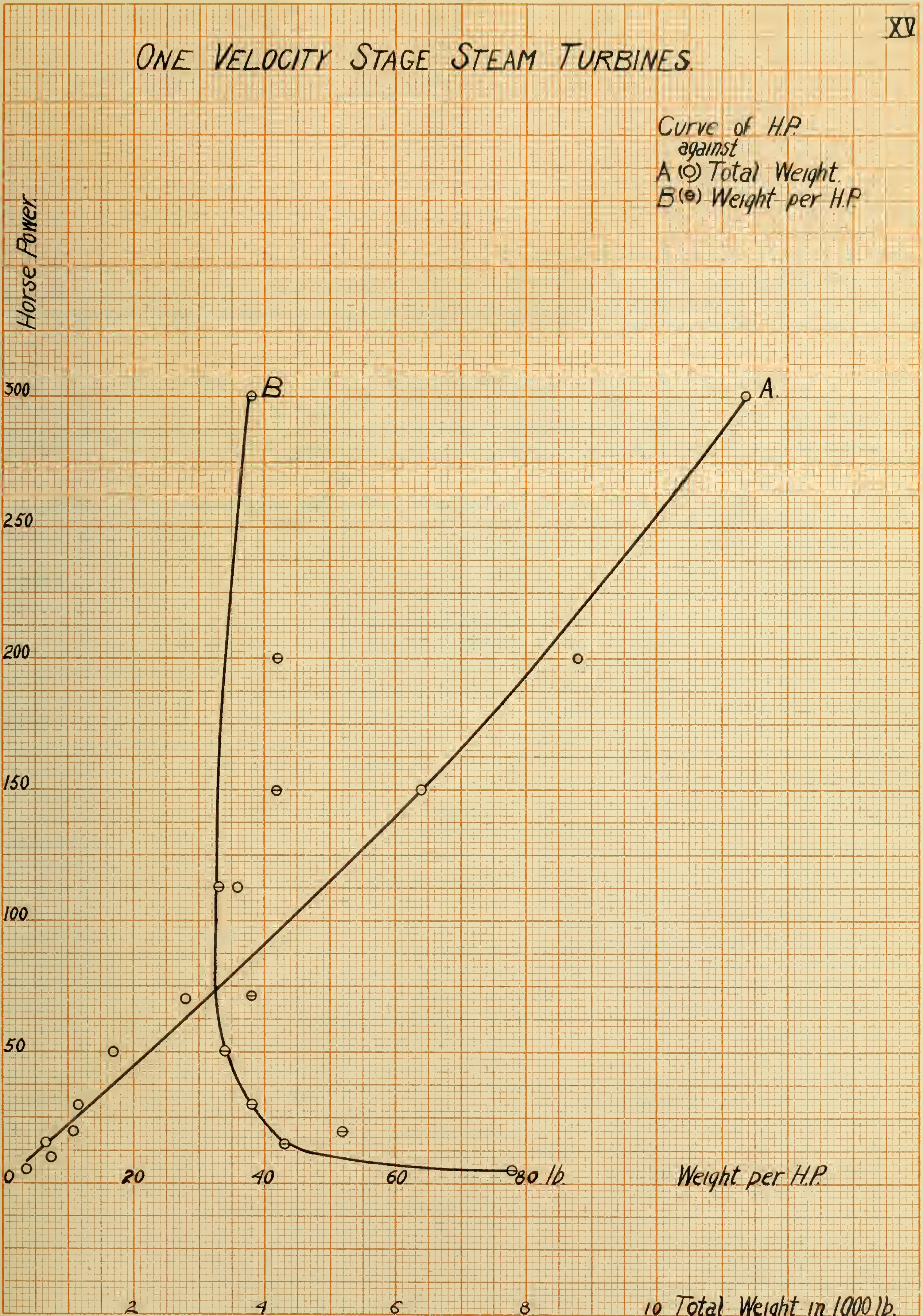

X
GASOLINE MARINE ENGINES
FOUR CYCLE VERTICAL TYPE
Curve of H.P. against
A (○) Total Weight.
B (⊕) Weight per H.P.
Horse Power.
100
80
60
40
20
0
B.
A.
20
40
60
80
100
120 lb.
Weight per H.P.
0
1600
3200
4800
6400
8000
9600
11200
Total Weight in lb.
U. OF I. S. S. FORM 3


XI.
GASOLINE AUTOMOBILE ENGINES
Curve of H.P. against
A (o) Total Weight.
B (⊕) Weight per H.P.
Horse Power.
70
60
40
30
20
10
0
B.
A.
4.
8
12
16
20 lb.
Weight per H.P.
200
400
600
800
1000 lb.
Total Weight.

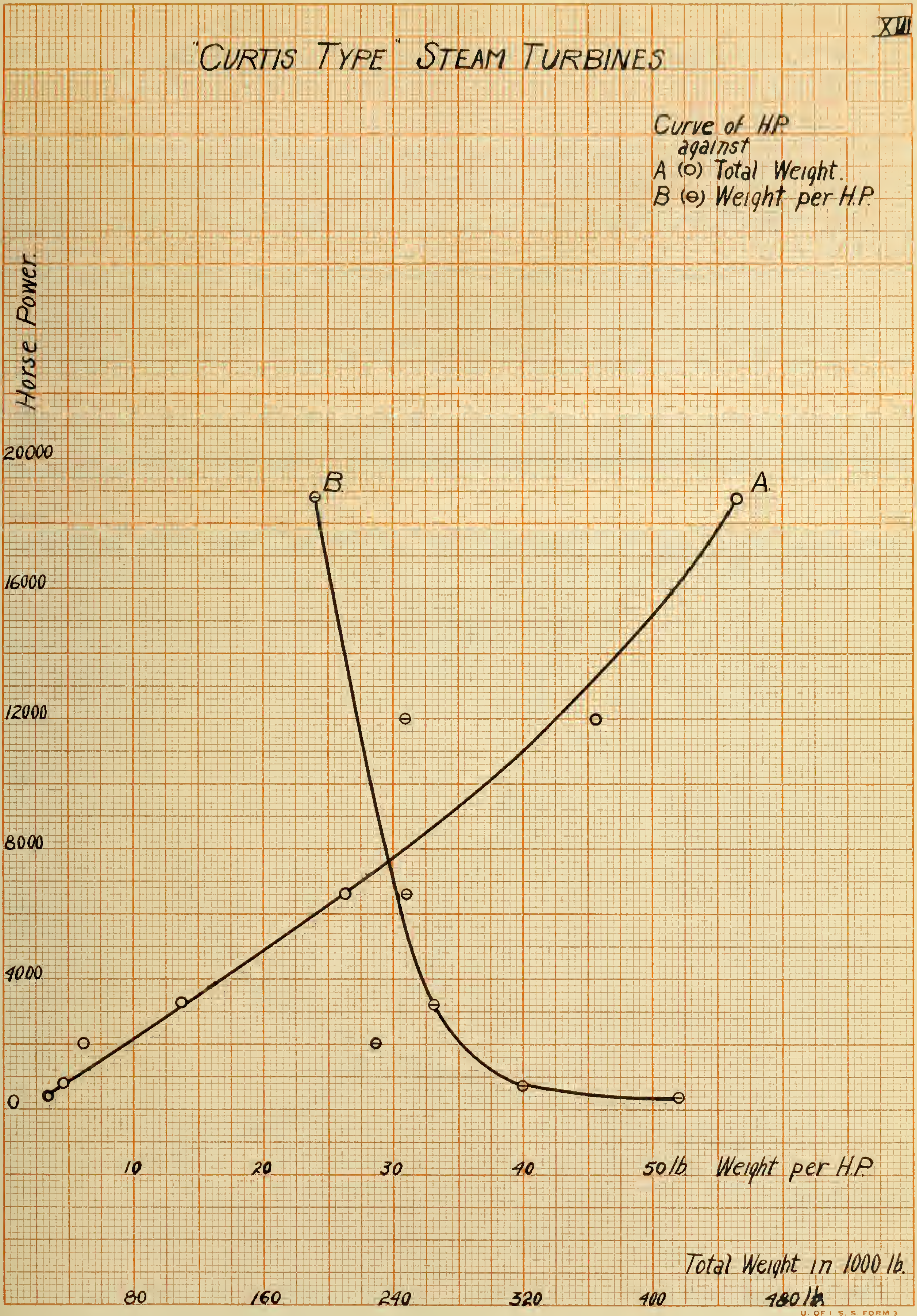

GASOLINE MOTORCYCLE ENGINES.
Curve of H.P. against
A (o) Total Weight.
B (⊕) Weight per H.P.
B.
A.
Horse Power.
1
2
3
4
5
6
7
0
5
10
15
20
25 lb. Weight per H.P.
0
20
40
60
80
100 lb. Total Weight.

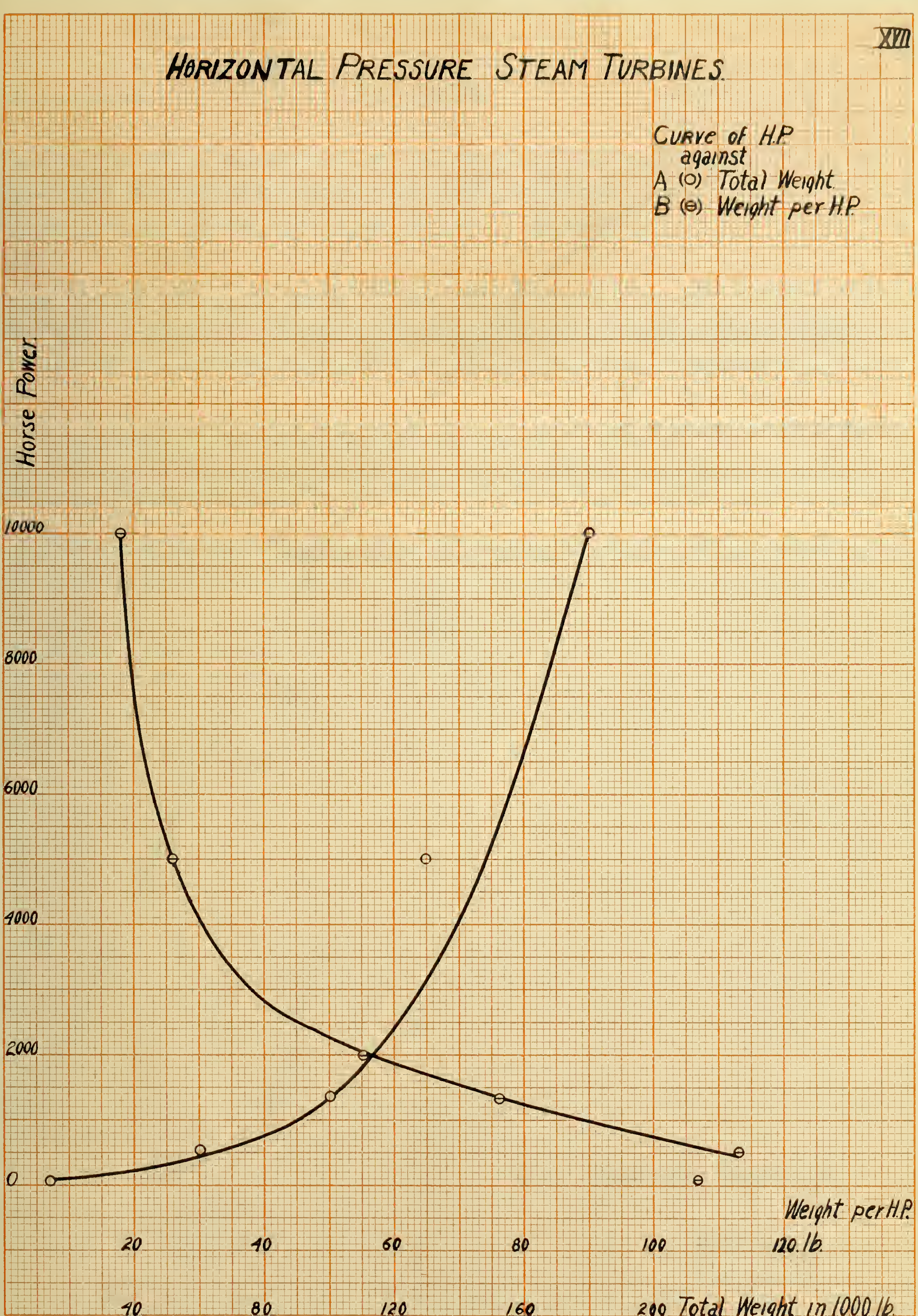
XIII.
GASOLINE AIRSHIP ENGINES.
(⊙) Total Weight.
(⊕) Weight per H.P.
Horse Power.
60
50
40
30
20
10
0
1
2
3
4
5
6
7lb.
Weight per H.P.
50
100
150
200
250
300 lb.
Total Weight.

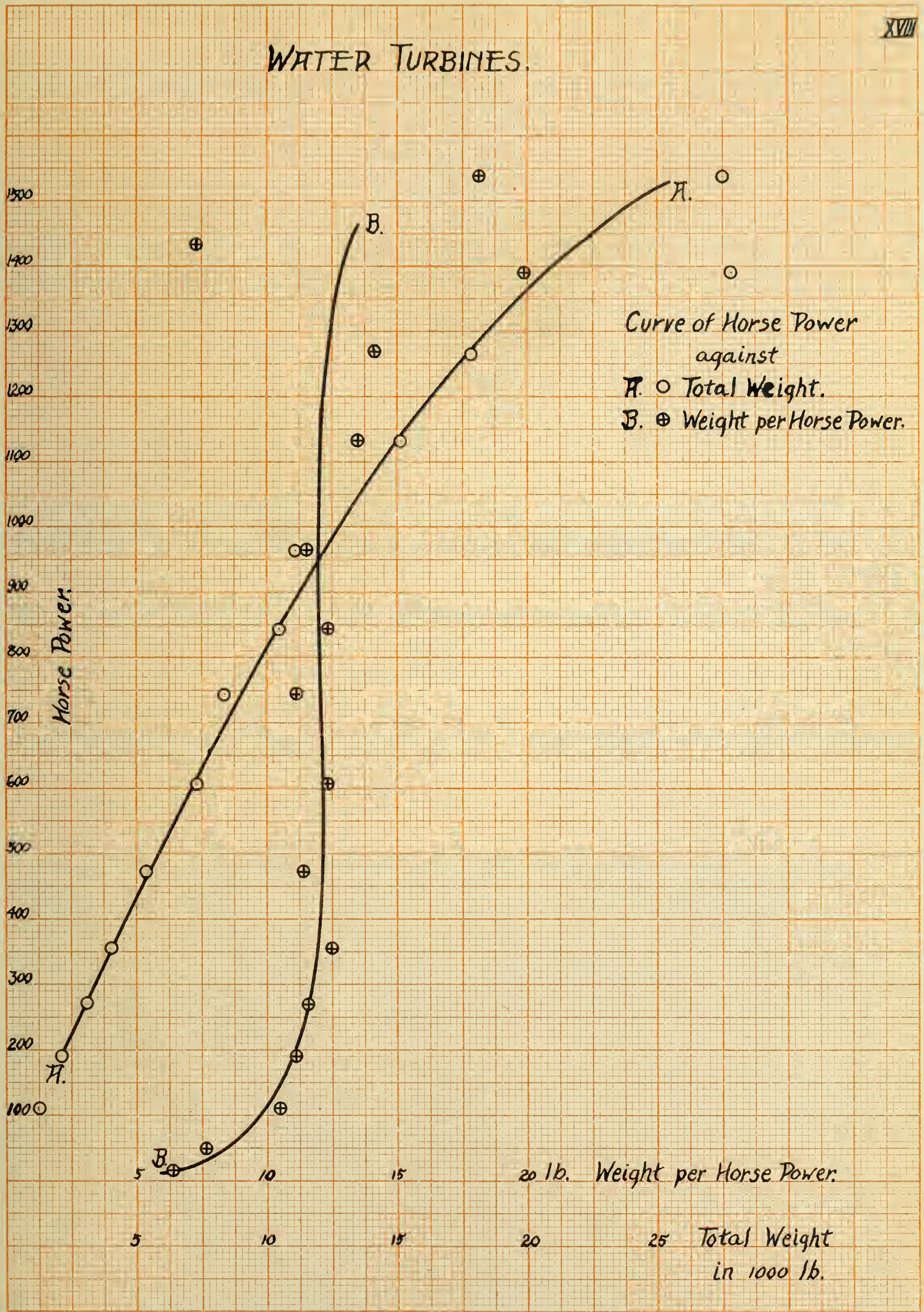

VERTICAL OIL ENGINES.
Curve of H.P. against
A (○) Total Weight.
B (⊖) Weight per H.P.
C (⊕) Floor Space.
Horse Power.
200
160
120
80
40
0
20
40
60
80
100 Sq. Ft. Floor Space.
40
80
120
160
200 lb. Weight per H.P.
Total Weight in 1000 lb.
5
10
15
20
25
30
35


ONE VELOCITY STAGE STEAM TURBINES.
Curve of H.P. against
A (O) Total Weight.
B (⊖) Weight per H.P.
Horse Power.
300
250
200
150
100
50
0
20
40
60
80 lb.
Weight per H.P.
2
4
6
8
10 Total Weight in 1000 lb.
B.
A.

XVII


"Curtis Type" Steam Turbines
Curve of H.P. against
A (o) Total Weight.
B (⊖) Weight per H.P.
Horse Power.
20000
16000
12000
8000
4000
0
B.
A.
10
20
30
40
50 lb.
Weight per H.P.
Total Weight in 1000 lb.
80
160
240
320
400
480 lb.
U. OF I. S. S. FORM 3


HORIZONTAL PRESSURE STEAM TURBINES.
Curve of H.P. against
A (○) Total Weight.
B (⊖) Weight per H.P.
Horse Power
10000
8000
6000
4000
2000
0
Weight per H.P.
20
40
60
80
100
120. lb.
40
80
120
160
200 Total Weight in 1000 lb.


WATER TURBINES.
Curve of Horse Power
against
A. ○ Total Weight.
B. ⊕ Weight per Horse Power.
Horse Power.
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
A.
B.
5
10
15
20 lb.
Weight per Horse Power.
25
Total Weight
in 1000 lb.

List of Contributors

of Data.

Relation between Weight and Capacity

of Prime Movers.

Thesis by

Sidney B. Wright and Ralph E. Holch.

1. Chandler and Taylor.	Indianapolis Ind.
2. Atlas Engine Works.	"
3. Erie City Iron Works.	Erie Pa.
4. Davenport Foundry and Machine Co.	Davenport Ia.
5. Jno. T. NOye Mfg. Co.	Buffalo N. Y.
6. A. L. Ide and Sons.	Springfield Ill.
7. Ames Iron Works.	Oswego N.Y.
8. Valley Iron Works.	Williamsport Pa,
9. New Britain Mach. Co.	New Britain Conn.
10. Ridgway Dynamo and Engine Co.	Ridgway Pa.
11. American Engine Co.	Bound Brook N.J.
12. Allis Chalmers.	Milwaukee. Wis.
13. Vilter Mfg. Co.	"
14. Bates Mach. Co.	Joliet. Ill.
15. St. Louis Iron and Mach. Co.	St Louis Mo.
16. Minneapolis Steel and Mach Co.	Minneapolis.
17. S. Morgan Smith Co.	York Pa.
18, Pool Engineering and Mach Co.	Baltimore. MD.
19. Platt Iron Works.	Dayton O.
20. Rider Ericsson Engine Co.	Chicago.
21. Baldwin Locomotive Works.	
22. Brooks Locomotive Works.	
23. American Locomotive Works.	
25. Great Western	
24. Central Pacific.	
26. L.S.& M.S.	
27. Schnectady Locomotive Works.	

28. Pennsylvania R. R.	
29. Rogers Locomotive Works.	
30. National Meter Co.	New York.
31. Olds Gas Power Co.	Lansing Mich.
32. Otto Gas Engine Co.	Philadelphia.
33. Bruce - Merriam - Abbott Co.	Cleveland O.
34. August Mietz Foundry and Mach Co.	New York.
35. American Diesel Engine Co.	New York.
36. S. M. Jones Co.	Toledo O.
37. Shelinger Marine Engine Co.	Detroit Mich.
38. Wolverine Motor Works.	Bridgeport Conn.
39. Scripps Motor Works.	Detroit.
40. Automatic Mach Co.	Bridgport CoNN,
41. Standard Motor Construction Co.	Jersey City N. J.
45. Dayton Gas Engine and Mfg. Co.	Dayton O.
46. Foss Gas Engine Co.	Springfield O,
47. Globe Iron Works.	Minneapolis.
48. Kinnard Haines Co.	"
49. Fairbanks Morse Co.	Detroit Mich.
50. Charter Gas Engine Co.	Sterling Ill.
51. New Era Gas Engine Co.	Dayton O.
52. Stauthers-Wells Co.	Warren Pa.
53. J. Cockerill.	Seraing Belgium.
54. (Under Deutz Patent.)	Germany.
55. Oechelhauser.	Germany.
56. De La Vergne Mach Co.	New York.
57. Westinghouse Mach Co.	Pittsburg Pa.

58. De Laval Turbine Co.	New York.
59. B. F. Sturtevant Co.	Hyde Park Mass.
60. General Electric Co.	Berlin Germany.
61. Gesellsehaft für Elektvische.	Karlsruhe Gemany.
62. The Terry Steam Turbine Co.	Hartford Conn.
63. Kerr Turbine Co.	Wellsville N.Y.
64. Sautter Harle and Co.	Paris France.
65. General Electric Co.	Schnectady N. Y.
66. Hooven, Owens, Rentschler.	Hamilton O,
67. Brown, Boverie, Parsons Co.	Essen England.
68. Mier Carriage and Buggy Co.	Segonier Ind.
69. Emancipator Auto Co.	Aurora Ill.
70. Fulton and Zenke.	Chicago.
71. Overland Automobile Co.	Indianapolis Ind.
72. Cadillac Motor Car Co.	Detroit Mich.
73. Haynes Automobile Co.	Kokomo Ind.
74. Peerless Motor Car Co.	Cleveland. O.
75. Model Gas Engine Co.	Peru Ind.
76. :ational Motor Vehicle Co.	Indianapolis Ind.
77. Dayton Motor Car Co.	Dayton O,
78. Plds Motor Works.	Lansing Mich.
79. Winton Motor Carriage Co.	Cleveland O,
80. N. S. U. Motor Co.	New York.
81. Excelsior Supply Co.	Chicago.
82. Pierce Cycle Co.	Buffalo N.Y.
83. G. H. Curtiss Mfg. Co.	Hammondsport N.Y.
84. Esnault Peltense Co.	Paris France.
85. Adams Co.	Dubuque Ia.

86.	Renault Co.	Paris France.
87.	Antionette Co.	Paris France.
88.	Dufour Co.	Switzerland.
89.	Minneapolis Steel and Mach Co.	Minneapolis.
90.	August Mietz Iron Foundry and Mach Co.	New York.